TABLES FOR ELECTRICAL ENGINEERS

PUBLISHED BY
JOHN A. ROEBLING'S SONS CO.
TRENTON, N.J., U.S.A.

HAND-BOOK OF TABLES

FOR

ELECTRICAL ENGINEERS.

PUBLISHED BY

JOHN A. ROEBLING'S SONS CO.

TRENTON, N. J., U. S. A.

The Brandt Press,
Trenton.
1892.

1741

TABLE OF CONTENTS.

C.—The Overhead Line.

D.—The Underground Line.

HAND-BOOK OF TABLES

FOR

ELECTRICAL ENGINEERS.

DEFINITIONS.

(From Brackett & Anthony's Physics.)

MEASUREMENTS.

All the phenomena of nature occur in *matter* and are presented to us in *space* and *time*. Time and space are fundamental conceptions; they do not admit of definition. Matter is equally indefinable; its distinctive characteristic is its persistence in whatever state of rest or motion it may happen to have, and the resistance which it offers to any attempt to change that state. This property is called *inertia*. If we adopt arbitrary units of length, time, and mass (or quantity of matter), we can express the measure of all other quantities in terms of these so-called *fundamental units*. A unit of any other quantity, thus expressed, is called a *derived unit*.

UNITS.

Units of Length.—The unit of length in the United States is the *foot*. The unit of length usually adopted in scientific work is the *centimeter*. It is the one-hundreth part of the length of a certain piece of platinum, declared to be the standard by legislative act, and preserved in the archives of France.

Unit of Time.—The unit of time is the *mean time second,* which is the $\frac{1}{86400}$ of a mean solar day.

Unit of Mass.—The unit of mass in the United States is the *avoirdupois pound.* The unit of mass usually adopted in scientific work is the *gram.* It is equal to the one-thousandth part of a certain piece of platinum, called the kilogram, preserved as a standard in the archives of France. This standard was intended to be equal in mass to one cubic decimeter of water at its greatest density.

Dimensions of Units.—Any derived unit may be represented by the product of certain powers of the symbols representing the fundamental units of length, mass, and time. Any equation showing what powers of the fundamental units enter into the expression for the derived unit is called its *dimensional equation.* In a dimensional equation time is represented by T, length by L, and mass by M. To indicate the dimensions of any quantity the symbol representing that quantity is enclosed in brackets.

Mass.—In many cases it is convenient to speak of the quantity of matter in a body as a whole. It is then called the *mass* of the body.

Density.—The *density* of any substance is defined as the limit of the ratio of the quantity of matter in any volume within the substance to that volume, when the volume is diminished indefinitely.

Particle.—A body constituting a part of a material system, and of dimensions such that they may be considered infinitely small in comparison with the distances separating it from all other parts of the system, is called a *particle.*

Motion.—The change in position of a material particle is called its *motion.*

Path.—The moving particle must always describe a continuous line or *path.*

Velocity.—The rate of motion of a particle is called its *velocity.* If the particle move in a straight line, and describe equal spaces in any arbitrary equal times, its velocity is constant. A constant velocity is measured by the ratio of the

space traversed by the particle to the time occupied in traversing that space.

Speed.—If the path of the particle be curved, or if the spaces described by the particle in equal times be not equal, its velocity is variable and is called the *speed.*

Momentum.—The *momentum* of a body is a quantity which varies with the mass and with the velocity of the body jointly, and is measured by their product.

Acceleration.—When the velocity of a particle varies, its rate of change is called the *acceleration* of the particle. Acceleration is either positive or negative, according as the velocity increases or diminishes. If the path of the particle be a straight line, and if equal changes in velocity occur in equal times, its acceleration is *constant.*

Simple Harmonic Motion.—If a point moves in a circle with a constant velocity, the point of intersection of a diameter and a perpendicular drawn from the moving point to this diameter, will have a *simple harmonic motion.*

Period.—The *period* is the time between any two successive recurrences of a particular condition of the moving point.

Phase.—The *phase* is the interval of time, expressed as a fraction of the period, which has elapsed since the point has passed through the middle of its path in the positive direction.

Displacement.—The *displacement* is the distance from the center of motion. We further define rotation in the positive direction as that rotation in the circle which is contrary to the motion of the hands of a clock, or counter-clockwise. Motion from left to right in the diameter is also considered positive. Displacement to the right of the center is positive, and to the left is negative.

Force.—Whenever any change occurs or tends to occur in the momentum of a body, we ascribe it to a cause called a *force.*

Field of Force.—A *field of force* is a region such that a particle constituting a part of a mutually interacting system, placed at any point in the region, will be acted on by a force, and will move, if free to do so, in the direction of the force. The particle so moving would, if it had no *inertia,* describe

what is called a *line of force*, the tangent to which at any point is the direction of the force at that point.

Inertia.—*Inertia* is not of itself a force, but the property of a body, enabling it to offer a resistance to a change of motion.

Work.—When a force causes motion through space, it is said to do *work.*

Energy.—A body may, in consequence of its motion or position with respect to other bodies, have a certain capacity for doing work. This capacity for doing work is its energy. *Potential energy* is due to the position of the body. *Kinetic energy* is due to the motion of the body.

Difference of Potential.—The *difference of potential* between two points in a field of force is measured by the work done in moving a test unit of the quantity to whose presence the force is due from one point to the other.

Absolute Potential.—The *absolute potential* at a point in a field of force is measured by the work done in moving a test unit of the quantity to whose presence the force is due from an infinite distance to that point.

Equipotential Surface.—A surface to which the lines of force are perpendicular is called an *equipotential surface.*

Moment of Force.—The *moment of force* about a point is defined as the product of the force and the perpendicular drawn from the point upon the line of direction of the force.

Couple.—The combination of two forces, equal and oppositely directed, acting on the ends of a rigid bar, is called a *couple.*

Moment of Couple.—The *moment of couple* is the product of either of the two forces into the perpendicular distance between them.

Center of Inertia.—If we consider any system of equal material particles, the point of which the distance from any plane is equal to the average distance of the several particles from that plane, is called the *center of inertia.*

Center of Gravity.—When the force acting is the force gravity the center of inertia is usually called the *center of gravity.*

Moment of Inertia.—The *moment of inertia* of any body about an axis is defined as the summanation of the products of the masses of the particles making up the body into the squares of their respective distances from the axis.

Stress and Strain.—When a body is made the medium for the transmission of force, there is a *stress* in the medium. This stress is always accompanied by a corresponding change of form of the body, called a *strain.*

Set.—If the strain be carried beyond the limit of perfect elasticity, the body is permanently deformed. This permanent deformation is called *set.*

Solid.—A *solid* requires the stress acting upon it to exceed a certain limit before any permanent set occurs, and it makes no difference how long the stress acts provided it lie within the limits.

Fluid.—A *fluid* may be deformed by the slightest shearing stress, provided time enough be allowed for the movement to take place.

Specific Gravity.—The *specific gravity* of a body is defined as the ratio of its weight to the weight of an equal volume of pure water at a standard temperature.

Temperature.—Two bodies are said to be at the same *temperature* when, if they be brought into intimate contact, no heat is transferred from one to the other. A body is at a high temperature relatively to other bodies when it gives up heat to them.

Unit of Heat.—The English *unit of heat* is the heat necessary to raise one pound of water at 60° F., one degree Fahrenheit. The unit of heat generally adopted in scientific works is the heat required to raise the temperature of one kilogram of water from zero to one degree C. It is called the *calorie.*

Specific Heat.—The quantity of heat required to raise the temperature of one kilogram of a substance from zero to one degree is called the *specific heat* of the substance.

MAGNETISM.

Masses of iron ore are sometimes found which possess the property of attracting pieces of iron and a few other sub-

stances. Such masses are called natural magnets or lodestone. A bar of steel may be so treated as to acquire similar properties. It is then called a *magnet.*

Poles.—In an ordinary bar-magnet there are two small regions, near the ends of the bar, at which the attractive powers of the magnet are most strongly manifested. These regions are called the *poles* of the magnet.

Magnetic Axis.—A line joining these two regions is called the *magnetic axis.*

Unit Magnetic Pole.—If two perfectly similar magnets, infinitely thin, uniformly and longitudinally magnetized, be so placed that their positive poles are unit distance apart, and if these poles repel one another with unit force, the magnet poles are said to be of *unit strength.*

Magnetic Moment.—The product of the strength of the positive pole of a uniformly and longitudinally magnetized magnet into the distance between its poles is called its *magnetic moment.*

Intensity of Magnetization.—The quotient of the magnetic moment of such a magnet by its volume, or the magnetic moment of unit of volume, is called the *intensity of magnetization.*

Magnetic Shell.—A *magnetic shell* may be defined as an infinitely thin sheet of magnetizable matter, magnetized transversely; so that any line in the shell normal to its surfaces may be looked on as an infinitesimally short and thin magnet. These imaginary magnets have their like poles contiguous. The product of the intensity of magnetization at any point in the shell into the thickness of the shell at that point is called the strength of the shell at that point.

Declination.—The *declination* is the angle between the magnetic meridian, or the direction assumed by the axis of a magnetic needle suspended to move freely in a horizontal plane, and the geographical meridian.

Dip.—The *dip* is the angle made with the horizontal by the axis of a magnetic needle suspended so as to turn freely in a vertical plane containing the magnetic meridian.

Horizontal Intensity.—The *horizontal intensity* is the strength of the earth's magnetic field resolved along the horizontal line in the plane of the magnetic meridian.

ELECTRICITY IN EQUILIBRIUM.

Unit Quantity of Electricity.—Let there be two equal and similar charges concentrated at points unit distance apart in air, such that the repulsion between them equals the unit of force, then each of the charges is a unit charge, or a *unit quantity of electricity.*

Capacity.—The electrical *capacity* of a conductor is defined to be the charge which the conductor must receive to raise it from zero to unit potential, while all other conductors in the field are kept at zero potential.

Specific Inductive Capacity.—The fact that the capacity of a condenser of given dimensions depends upon the medium used as the dielectric was first discovered by Cavendish and afterwards rediscovered by Faraday. The property of the medium upon which this fact depends is called its *specific inductive capacity.*

ELECTRICITY IN MOTION.

Electromotive Force.—The power of maintaining a difference of potential is ascribed to an E. M. F. existing in the circuit.

Current.—The transfer of electricity in the circuit is called the electrical *current,* and the rate of transfer is called the current strength, and often simply the current. The current as here defined is independent of the nature of the conductor, and is the same for all parts of the circuit.

Electro-Magnetic Unit of Current.—That current is defined as the *unit current* which will set up the same magnetic field as that due to a magnetic shell of which the edge coincides with the circuit and the strength is unity.

Ohm's Law.—It was shown on theoretical consideration in 1827, by Ohm, of Berlin, that in a homogeneous conductor which is kept constant, the current varies directly with the difference of potential between the terminals.

Resistance.—We may define the ratio of the electromotive force to the current in any circuit as the *resistance* in that circuit.

Specific Conductivity and Specific Resistance.—If two points be kept at a constant difference of potential, and joined by a homogeneous conductor of uniform cross-section, it is found that the current in the conductor is directly proportional to its cross-section and inversely as its length. The current also depends upon the nature of the conductor. If conductors of similar dimensions, but of different materials, are used, the current in each is proportional to a quantity called the *specific conductivity* of the material. The numerical value of the current set up in a conducting cube, with edges of unit length, by unit difference of potential between two opposite faces, is the *measure of the conductivity* of the material of the cube. The reciprocal of this member is the *specific resistance* of the material.

Kirchhoff's Laws.—*Kirchhoff's laws* may be stated as follows: (1.) The algebraic sum of all the currents meeting at any point of junction of two or more branches is equal to zero. This first law is evident, because, after the current has become steady, there is no accumulation of electricity at the junctions. (2.) The sum, taken around any number of branches forming a closed circuit, of the products of the currents in those branches into their respective resistances is equal to the sum of the electromotive forces in those branches. This law can easily be seen to be only a modified statement of Ohm's law.

Self-Induction.—When a current is set up in any circuit, the different parts of the circuit act on one another in the relation of primary and secondary circuits. In a long straight wire, for example, the current which is set up through any small area in the cross-section of the wire tends to develop an opposing electro-motive force through every other area in the same cross-section. The true current will thus be temporarily weakened, and will require a certain time to attain its full strength. On the other hand, when the circuit is broken, the induced electro-motive force is in the same direction as the electro-motive force of the circuit. Since the time occupied by the change of the true current from its full value to zero, when

the circuit is broken, is very small, the induced electro-motive force is very great. The current formed at breaking is called the *extra current*, and gives rise to a spark at the point where the circuit is broken. The extra current may be heightened by anything which will increase the change in the number of lines of force, as by winding the wire in a coil and by inserting in the coil a piece of soft iron. This action of a circuit on itself is called *self-induction.*

Induced Currents.—It has been shown by experiment that the movement of a magnet in the neighborhood of a closed circuit will give rise, in general, to an electro-motive force in the circuit, and that the current due to this electro-motive force will be in the direction opposite to that current which, by its action upon the magnet, would assist the actual motion of the magnet. This current is called an *induced current.* From the equivalence between a magnetic shell and an electrical current, it is plain that a similar induced current will be produced in a closed circuit by the movement near it of an electrical current or any part of one. Since the joining up or breaking the circuit carrying a current is equivalent to bringing up that same current from an infinite distance, or removing it to an infinite distance, it is further evident that similar induced currents will be produced in a closed circuit when a circuit is made or broken in its presence.

Ampere's Law for Mutual Action of Currents.—Ampere's *first case* of equilibrium shows that the forces due to two currents identical in strength and in position but opposite in direction are equal and opposite. Ampere's *second case* of equilibrium shows that the action of the elements of the curved conductor is the same as that of their projections on the straight conductor. The *third case* of equilibrium: the deduction from this observation is that no closed circuit tends to displace an element of current in the direction of its length. From the *fourth case* of equilibrium, is deduced the law that the force between two current elements is inversely as the square of the distance between them.

Electrolysis.—In certain cases, the existence of an electrical current in a circuit is accompanied by the decomposition into their constituents of chemical compounds forming part of the

circuit. This process is called *electrolysis*. Bodies which can be decomposed were called by Faraday, to whom the nomenclature of this subject is due, *electrolytes*. The current is usually introduced into the electrolyte by solid terminals called *electrodes*. The one at the higher potential is called the positive electrode or *anode;* the other, the negative electrode, or *cathode*. The two constituents into which the electrolyte is decomposed are called *ions*. One of them appears at the anode, and is called *anion;* the other, at the cathode, and is called the *cation*.

Faraday's Laws.—(1.) The amount of an electrolyte decomposed is directly proportional to the quantity of electricity which passes through it; or, the rate at which a body is electrolyzed is proportional to the current strength. (2.) If the same current be passed through different electrolytes, the quantity of each ion evolved is proportional to its chemical equivalent. If we define an *electro-chemical equivalent* as the quantity of any ion which is evolved by unit current in unit time, then the two laws may be summed up by saying: The number of electrochemical equivalents evolved in a given time by the passage of any current through any electrolyte is equal to the number of units of electricity which pass through the electrolyte in the given time.

LAWS OF DYNAMIC ELECTRIC CIRCUITS.

(From Clark & Sabine.)

1. The strength of a galvanic current is equal to the quantity of electricity flowing per second, and is the same in every point of an undivided conductor.

2. The strength of the current is proportional to the electromotive force, when the resistance remains constant.—(*Ohm.*)

3. The current strength is inversely proportional to the resistance of the conductor, and therefore directly proportional to its conducting power.—(*Ohm.*)

4. The current strength is equal to the electromotive force divided by the resistance.

5. The current strength obtained with a battery of given surface is at its maximum when the plates are so divided that the internal resistance of the battery is equal to that of the circuit without.—(*Jacobi.*)

6. The sum of the current strengths in all those wires which converge to a point is equal to nothing.—(*Kirchhoff.*)

7. The sum of all the products of the intensities and resistances in all the wires which form an enclosed figure is equal to the sum of all the electromotive forces in the same circuit.—(*Kirchhoff.*)

8. If, in any system of circuits, containing any electromotive forces, a conductor exists in which the current strength is equal to nothing, the currents in the remaining circuits will not be altered, in the least, if the circuit of the conductor in question be separated or removed together with whatever electromotive force it may contain.

9. If the conductor in question contains no electromotive force, the currents will not be altered if, after its removal, the points between which it previously existed be connected directly with each other.—(*Bosscha.*)

10. If, on the other hand, it contained an electromotive force, the points can only be joined again, whilst retaining the balance, by inserting between them an equivalent electromotive force, but irrespective of the resistance which may accompany it.—(*Bosscha.*)

11. In a system of linear conductors, containing electromotive forces, the current set up in any conductor, *A*, by any electromotive force contained in any other conductor, *B*, will be identically the same as that which would be set up in *B* by an equal electromotive force in *A*.—(*Bosscha.*)

12. If, in a system of electromotive forces and conductors, there be two of the latter, say *A* and *B*, in which the electromotive force in *A* occasions no current in *B*, whatever current may be circulating in *B* will not be affected if *A* be interrupted or removed; nor will the current in *A* be altered if *B* be interrupted or removed, however the electromotive forces in the other circuits may be arranged.—(*Bosscha.*)

13. In any linear conductor through which a current of electricity is flowing, the difference of potential, between any two points with a given resistance between them is the same as that between any other two points having between them an equal resistance.—(*Ohm.*)

LAWS OF VOLTAIC INDUCTION.

1. In a secondary closed circuit, the excited induction current is proportional to the current strength in the primary circuit.

2. The induction currents arising from the action of a galvanic current upon itself are, both on breaking and making the circuit, equally great so long as the inducing current strength remains equal.—(*Edlund.*)

3. When a metallic closed circuit and a conductor through which an electric current is circulating are either brought nearer to each other or separated, a current is induced in the metallic closed circuit. This current is in the reverse direction to that which would have been necessary to effect the approach or separation of itself.—(*Lenz.*)

4. The electromotive force which a magnet excites in a helix of wire is, other things being equal, proportional to the number of convolutions of the wire.—(*Lenz.*)

5. The electromotive force which a magnet excites in a surrounding helix is equal, whatever may be the radius of the coil. Therefore, the currents induced in the different rings of wire are inversely proportional to their diameters.—(*Lenz.*)

6. The electromotive force excited by a magnet in a helix of given number of turns is the same, whatever may be the thickness or conducting power of the wire.

7. The strengths of the induction currents in different spirals of equal number of turns are proportional to their conducting powers.

8. The longer the connecting wires are, so much more numerous should be the convolutions in order to obtain the maximum current.

9. The more turns which can be put next to each other close by the magnet or magnetized armature, the fewer turns will be necessary to give a maximum current.

10. The maximum of an induction current is proportional to the strength of the inducing magnet.—(*Lenz.*)

11. The retardation of the development of magnetism in soft iron cores which are wholly covered by helices, depends principally upon the opposite currents induced in the helices themselves. The magnetism of the simultaneous currents induced in the periphery of the core, and the coercive force of iron, are of less influence.—(*Beets.*)

12. The retardation of the disappearance of the magnetism from soft iron cores which are wholly covered with galvanic helices, depends however principally upon the formation of currents in the periphery of the soft iron cores.—(*Beets.*)

13. The retardations of development and disappearance of magnetism in soft iron cores which are only partially covered with helices, depends principally upon the magnetic inertia of the iron.

LAWS OF MAGNETISM.

1. A magnetic field is any space in the neighborhood or under the influence of a magnet.—(*B. A. Report.*)

2. The direction of the force in the field is the direction in which any pole is urged by the magnetism of the field; this is the direction which a short, balanced, freely-suspended magnet would assume.

3. A uniform magnet field is one in which the intensity is equal throughout, and hence the lines of force parallel.—(*Thomson.*)

4. Opposite poles attract each other; similar poles repel each other.

5. The forces directed from any magnetic point upon equal masses are reciprocally proportional to the square of the distance.—(*Musschenbroek.*)

6. When two magnets are very small and the distance between them very great in proportion to their length, the magnetic action between them is reciprocally proportional to the cube of their distance.—(*Gauss.*)

7. The force directed from any magnet point upon any other mass upon which it acts is reciprocally proportional to the square of the distance. The total action between them both is, however, reciprocally proportional to the third power of the distance, when the latter is great.—(*Gauss.*)

8. Magnetic forces between a suspended magnet and any mass upon which it acts are proportional to the square of the number of oscillations which (under their mutual action alone) the same magnet makes in a given time.—(*Coulomb.*)

9. Magnetic forces between a suspended magnet and any magnetic mass are inversely proportional to the square of the time which the suspended magnet takes to complete one oscillation.—(*Coulomb.*)

10. The attraction of a magnet for an armature is proportional to the square of its free magnetism.

11. The magnetism excited at any given transverse section of a magnet is proportional to the square root of the distance between the given section and the nearest end of the magnet. —(*Dub.*)

12. The free magnetism at any given transverse section of a magnet is proportional to the difference between the square root of half the length of the magnet and the square root of the distance between the given section and the nearest end.—(*Dub.*)

LAWS OF ELECTRO-MAGNETISM.

1. If we imagine a positive current to flow through the axis of an ordinary corkscrew, the tip of the latter, in any position, represents the direction assumed by the north end of a magnet. If a current circulate in the corkscrew-helix in the direction in which it is turned, a soft iron core in its center will have its north end towards the tip.—(*L. Clark.*)

2. The total effect of any infinitely long and straight conductor upon any magnetic element is inversely proportional to the perpendicular distance between element and the conductor. —(*Biot and Savart.*)

3. A magnetic element in the axis of a circular current is attracted or repelled from the center with a force which is directly proportional to the superficial content of the circle and inversely to the third power of the distance of the element from the periphery.—(*Weber.*)

4. A circular current flowing in the plane of the magnetic meridian deflects a magnetic needle (which is infinitely short in comparison with the radius of the current) so that the tangent of the angle of deflection is proportional to the strength of the current.—(*Weber.*)

5. The magnetic intensity of a single deflected needle is without influence upon the angle of deflection.—(*Weber.*)

6. If the circular conductor be turned after the deflected needle until the latter again coincides with the plane of the former, the current strength is proportional to the sine of the angle through which the conductor is turned.

7. In electro-magnets, the south pole is always found at that end where the positive current enters a right-handed helix.

8. The free magnetism of the end-faces of an electro-magnet is proportional to the current strength in its helix.—(*Dub.*)

9. The attraction between electro-magnets is proportional to the square of the strength of the magnetizing current.

10. The material and the thickness of the helix wire of an electro-magnet are, when the current is equal, without influence upon its magnetism.—(*Lenz.*)

11. The free magnetism of an electro-magnet, with a given current strength, is directly proportional to the number of turns of its helix.—(*Jacobi.*)

12. Its attraction is proportional to the square of the number of convolutions.—(*Dub.*)

13. The attraction between two electro-magnets is proportional to the sum of the products of the current strength and number of convolutions of both helices.

14. The force with which a bar of soft iron is attracted by a galvanic helix is proportional to the square of the product of current strength and number of convolutions of the helix.—(*Dub.*)

15. The force with which a saturated steel magnet is attracted by a galvanic helix is directly proportional to the product of the current strength and number of convolutions.

16. The free magnetism of a solid cylindrical soft iron core of given length is, other things being equal, proportional to the square root of its diameter.—(*Nicklès.*)

17. The free magnetism at the poles of a horse-shoe magnet is, other things being equal, proportional to the square root of the length.

18. The free magnetism of any given transverse section of an electro-magnet is proportional to the difference between the square root of half the length and the square root of the distance of the given section from the nearest end.—(*Dub.*)

19. The poles of an electro-magnet attract most favorably when their faces have the same area as the transverse section of the magnet.

20. The attraction between an electro-magnet and its armature increases when the mass of the armature is increased.

21. The magnetizing powers of coils of one and the same metal, with the same surface of battery plates, arranged so as to give a maximum strength of current in each case, are as the square roots of the weights of the metallic wire used.—(*Menzzer.*)

FORMULÆ AND DIMENSIONS OF UNITS.

The formulæ of these tables are the algebraic expression of the definitions which have preceded. In the case of the Fundamental Units and the Derived Mechanical Units they are in the form in which they are commonly used for calculation, but in the case of the Magnetic and Electrical Units more special expressions are preferred, ones in which the force, F, is expressed in its mechanical equivalent involving the constants of conversion.

FUNDAMENTAL UNITS.

Unit.	Formula.	Dimensions.
Length	s	L
Mass	m	M
Time	t	T

DERIVED MECHANICAL UNITS.

Unit.	Formula.	Dimensions.
Area	$A = s^2$	L^2
Volume	$V = s^3$	L^3
Velocity	$V = \frac{s}{t}$	LT^{-1}
Acceleration	$f = \frac{v - v_0}{t}$	LT^{-2}
Momentum	$mv = \frac{ms}{t}$	MLT^{-1}
Density	$d = \frac{m}{V}$	ML^{-3}
Force	$F = mf = m\frac{v - v_0}{t}$	MLT^{-2}
Weight	$w = mf = mg$	MLT^{-2}
Work	$W = Fs = mfs$	ML^2T^{-2}

DERIVED MECHANICAL UNITS—*Continued.*

Unit.	Formula.	Dimensions.
Simple Harmonic Motion.....	$s = a \cos. \frac{2\pi t}{T}$	
	$v = -\frac{2\pi a}{T} \text{sine} \frac{2\pi t}{T}$	
	$f = -\frac{4\pi^2}{T^2} a \cos. \frac{2\pi t}{T}$	
Kinetic Energy....................	$K = \frac{m v^2}{2}$	$M L^2 T^{-2}$
Potential Energy.................	$P = \Sigma m f s$	$M L^2 T^{-2}$
Energy	$E = K + P = \frac{m v^2}{2} + \Sigma m f s$	$M L^2 T^{-2}$
Moment of Couple	$= F s = m f s$	$M L^2 T^{-2}$
Angular Velocity..................	* $= \frac{1}{t}$	T^{-1}
Angular Acceleration...........	* $= \frac{1}{t^2}$	T^{-2}
Moment of Inertia	$I = \Sigma m s^2$	$M L^2$
Moment of Momentum.........	$= \Sigma \frac{m s^2}{t}$	$M L^2 T^{-1}$
Intensity of Pressure............	$\frac{F}{A} = \frac{m f}{s^2}$	$M L^{-1} T^{-2}$

DERIVED MAGNETIC UNITS.

Unit.	Formula.	Dimensions.
Magnetic Pole......................	$= \sqrt{F s^2}$	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-1}$
Magnetic Moment................	$= S \sqrt{F s^2}$	$M^{\frac{1}{2}} L^{\frac{5}{2}} T^{-1}$
Intensity of Magnetization...	$= S \frac{\sqrt{F s^2}}{s^3}$	$M^{\frac{1}{2}} L^{-\frac{1}{2}} T^{-1}$
Magnetic Density.................	$= \frac{\sqrt{F s^2}}{s^2}$	$M^{\frac{1}{2}} L^{-\frac{1}{2}} T^{-1}$
Magnetic Shell	$= \frac{s^2 \sqrt{F s}}{s^3}$	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$
Horizontal Intensity	$= \frac{F}{\sqrt{F s^2}}$	$M^{\frac{1}{2}} L^{-\frac{1}{2}} T^{-1}$
Magnetic Potential...............	$= \frac{F s}{\sqrt{F s^2}}$	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$

* In these formulæ the angles are measured in radians.

DERIVED ELECTROSTATIC UNITS.

Unit.	Formula.	Dimensions.
Current	$=\frac{\sqrt{F s^2}}{t}$	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$
Electromotive force	$=\frac{W}{\sqrt{F s^2}}$	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$
Resistance	$\frac{W}{\sqrt{F s^2}} \div \frac{\sqrt{F s^2}}{t}$	$L^{-1} T$
Quantity	$=\sqrt{F s^2}$	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-1}$
Capacity	$\sqrt{F s^2} \div \frac{\sqrt{F s^2}}{t}$	L
Difference of Potential	$\frac{W}{\sqrt{F s^2}}$	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$
Specific Inductive Capacity	$\frac{\sqrt{F s^2}}{\sqrt{F_1 s_1{}^2}}$	

DERIVED ELECTRO-MAGNETIC UNITS.

Unit.	Formula.	Dimensions.
Current	Fs	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$
Electromotive force	$\frac{W}{Fst}$	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$
Resistance	$\frac{W}{Fst} \div Fs$	$L T^{-1}$
Quantity	Fst	$M^{\frac{1}{2}} L^{\frac{1}{2}}$
Capacity	$Fst \div \frac{W}{Fst}$	$L^{-1} T^{-2}$
Difference of Potential	$\frac{W}{Fst}$	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$

TABLE FOR TRIGONOMETRICAL TRANSFORMATIONS.

	Sine.	Cosine.	Tangent.	Cotangent.	Secant.	Cosecant.
Sine	Sine x	$\sqrt{1-\cos.^2 x}$	$\frac{\tan. x}{\sqrt{1+\tan.^2 x}}$	$\frac{1}{\sqrt{1+\cot.^2 x}}$	$\frac{\sqrt{\sec.^2 x-1}}{\sec. x}$	$\frac{1}{\operatorname{cosec}. x}$
Cosine	$\sqrt{1-\sin.^2 x}$	Cosine x	$\frac{1}{\sqrt{1+\tan.^2 x}}$	$\frac{\cot. x}{\sqrt{1+\cot.^2 x}}$	$\frac{1}{\sec. x}$	$\frac{\sqrt{\operatorname{cosec}.^2 x-1}}{\operatorname{cosec}. x}$
Tangent	$\frac{\sin. x}{\sqrt{1-\sin.^2 x}}$	$\frac{\sqrt{1-\cos.^2 x}}{\cos. x}$	Tangent x	$\frac{1}{\cot. x}$	$\sqrt{\sec.^2 x-1}$	$\frac{1}{\sqrt{\operatorname{cosec}.^2 x-1}}$
Cotangent	$\frac{\sqrt{1-\sin.^2 x}}{\sin. x}$	$\frac{\cos. x}{\sqrt{1-\cos.^2 x}}$	$\frac{1}{\tan. x}$	Cotangent x	$\frac{1}{\sqrt{\sec.^2 x-1}}$	$\sqrt{\operatorname{cosec}.^2 x-1}$
Secant	$\frac{1}{\sqrt{1-\sin.^2 x}}$	$\frac{1}{\cos. x}$	$\sqrt{1+\tan.^2 x}$	$\frac{\sqrt{1+\cot.^2 x}}{\cot. x}$	Secant x	$\frac{\operatorname{cosec}. x}{\sqrt{\operatorname{cosec}.^2 x-1}}$
Cosecant	$\frac{1}{\sin. x}$	$\frac{1}{\sqrt{1-\cos.^2 x}}$	$\frac{\sqrt{1+\tan.^2 x}}{\tan. x}$	$\sqrt{1+\cot.^2 x}$	$\frac{\sec. x}{\sqrt{\sec.^2 x-1}}$	Cosecant x

MEASURES OF LENGTH.

NAME OF UNIT.	Inches.	Feet.	Yards.	Meters.	Chains.	Kilometers.	Miles.	Knots.
Inches	1.	.083 33	.027 78	.025 399	.001 263	.000 025 4	.000 015 8	.000 013 7
Feet	12.000 00	1.	.333 33	.304 795	.015 151	.000 304 8	.000 189 4	.000 164 3
Yards	36.000 00	3.000 00	1.	.914 384	.045 454	.000 914 4	.000 568 2	.000 492 8
Meters	39.370 79	3.280 90	1.093 63	1.	.049 710	.001 000 0	.000 621 3	.000 539 0
Chains.........	792.000 00	66.000 00	22.000 00	20.116 437	1.	.020 116 4	.012 500 0	.010 842 7
Kilometers...	39 370.79	3 280.899 16	1 093.633 05	1 000.000 000	49.710 479	1.	.621 381 0	.539 001 0
Miles...........	63 360.000 00	5 280.000 00	1 760.000 00	1 609.314 926	80.000 000	1.609 314 9	1.	.867 422 3
Knots	73 044.000 00	6 087.000 00	2 029.000 00	1 855.284 082	92.227 272	1.855 284 0	1.152 840 9	1.

LOGARITHMS OF MEASURES OF LENGTH.

NAME OF UNIT.	Inches.	Feet.	Yards.	Meters.	Chains.	Kilometers.	Miles.	Knots.
Inches	0.000 000	$\bar{2}$.920 801	$\bar{2}$.443 732	$\bar{2}$.404 817	$\bar{3}$.101 403	$\bar{5}$.404 817	$\bar{5}$.198 657	$\bar{5}$.136 721
Feet	1.079 181	0.000 000	$\bar{1}$.522 874	$\bar{1}$.484 007	2.180 442	$\bar{4}$.484 007	$\bar{4}$.277 380	$\bar{4}$.215 638
Yards	1.556 303	0.477 121	0.000 000	$\bar{1}$.961 128	$\bar{2}$.657 572	$\bar{4}$.961 128	$\bar{4}$.754 501	$\bar{4}$.692 671
Meters.........	1.595 174	0.515 993	0.038 871	0.000 000	$\bar{2}$.696 448	$\bar{3}$.000 000	$\bar{4}$.793 301	$\bar{4}$.731 589
Chains.........	2.898 725	1.819 544	1.342 423	1.303 551	0.000 000	$\bar{2}$.303 551	$\bar{2}$.096 910	$\bar{2}$.035 138
Kilometers...	4.595 174	3.515 993	3.038 871	3.000 000	1.696 448	0.000 000	$\bar{1}$.793 357	$\bar{1}$.731 589
Miles	4.801 815	3.722 634	3.245 513	3.206 641	1.903 090	0.206 641	0.000 000	$\bar{1}$.938 230
Knots	4 863 585	3.784 403	3.307 282	3.268 410	1.964 859	0.268 411	0.061 768	0.000 000

MEASURES OF AREA.

Name of Unit.	Square Centimeters.	Square Inches.	Square Feet.	Square Yards.	Square Meters.
Square Centimeters	1.	.155	.001 076	.000 119 61	.000 100
Square Inches	6.451 6	1.	.006 944	.000 771 60	.000 645
Square Feet	928.989	144.000	1.	.111 111 11	.092 898
Square Yards	8 361.	1 296.000	9.000 000	1.	.836 100
Square Meters	10 000.000 0	1 550.030	10.764 000	1.196 100 00	1.

LOGARITHMS OF MEASURES OF AREA.

Name of Unit.	Square Centimeters.	Square Inches.	Square Feet.	Square Yards.	Square Meters.
Square Centimeters	0.000 000	1.190 332	$\bar{3}$.031 812	$\bar{4}$.077 767	$\bar{4}$.000 000
Square Inches	0.809 667	0.000 000	$\bar{3}$.841 610	$\bar{4}$.887 392	$\bar{4}$.809 560
Square Feet	2.968 010	2.158 362	0.000 000	$\bar{1}$.045 757	$\bar{2}$.968 006
Square Yards	3.922 258	3.112 605	0.954 242	0.000 000	$\bar{1}$.922 258
Square Meters	4.000 000	3.190 340	1.031 974	0.077 767	0.000 000

MEASURES OF VOLUME.

Name of Unit.	Cubic Centimeters.	Cubic Inches.	Liters.	Gallons.	Cubic Feet.	Cubic Yards.	Cubic Meters.
Cubic Centimeters......	1.	.061 02	.001	.000 264	.000 035 3	.000 001 31	.000 001 0
Cubic Inches............	16.386	1.	.016 39	.004 33	.000 578 7	.000 021 40	.000 016 4
Liters......................	1 000.000	61.027 00	1.	.264 189	.035 317	.001 308	.001 000 0
Gallons....................	3 785.210	231.000 00	3.785 21	1.	.133 681	.004 952	.003 785 2
Cubic Feet................	28 315.336	1 728.000 00	28.315 33	7.480 5	1.	.037 037 03	.028 315 3
Cubic Yards..............	764 505.000	46 656.000 00	764.505	201.974	27.000 0	1.	.764 505
Cubic Meters	1 000 000.000	61 027.000 00	1 000.	264.189	35.316 9	1.308 0	1.

LOGARITHMS OF MEASURES OF VOLUME.

Name of Unit.	Cubic Centimeters.	Cubic Inches.	Liters.	Gallons.	Cubic Feet.	Cubic Yards.	Cubic Meters.
Cubic Centimeters......	0.000 000	$\bar{2}$.785 472	3.000 000	$\bar{4}$.421 604	$\bar{5}$.547 775	$\bar{6}$.117 271	$\bar{6}$.000 000
Cubic Inches	1.214 474	0.000 000	$\bar{2}$.214 579	$\bar{3}$.636 488	$\bar{4}$.762 453	$\bar{5}$.330 414	$\bar{5}$.214 844
Liters......................	3.000 000	1.785 522	0.000 000	$\bar{1}$.421 914	$\bar{2}$.547 983	$\bar{3}$.116 608	$\bar{3}$.000 000
Gallons....................	3.578 090	2.363 612	0.578 090	0.000 000	$\bar{1}$.126 009	$\bar{3}$.694 781	$\bar{3}$.578 089
Cubic Feet	4.452 022	3.237 544	1.452 022	0.873 931	0.000 000	$\bar{2}$.568 636	$\bar{2}$.452 021
Cubic Yards..............	5.883 397	4.668 908	2.883 396	2.305 296	1.431 364	0.000 000	$\bar{1}$.883 380
Cubic Meters	6.000 000	4.785 522	3.000 000	2.421 914	1.547 983	0.116 608	0.000 000

MEASURES OF WEIGHT.

Name of Unit.	Grains.	Grams.	Ounces Avoirdupois.	Pounds Troy.	Pounds Avoirdupois.	Kilograms.	Long Tons.
Grains......	1.	.064 80	.002 28	.000 174	.000 143	.000 064 8	....
Grams......	15.432	1.	.035 27	.002 68	.002 204	.001 000 0	....
Oz. Avd.....	437.500	28.350	1.	.075 95	.062 500	.028 350	.000 028
Lbs. Troy...	5 760.000	373.250	13.166	1.	.822 857	.373 250	.000 367
Lbs. Avd...	7 000.000	453.603	16.000	1.215 3	1.	.453 603	.000 447
Kilograms.	15 432.	1 000.000	35.273	2.679 2	2.204 571	1.	.000 984
Long Tons.	15 680 000.000	1 016 070.502	35 840.000	2 722.222 2	2 240.000 000	1 016.070 502	1.

LOGARITHMS OF MEASURES OF WEIGHT.

Name of Unit.	Grains.	Grams.	Ounces Avoirdupois.	Pounds Troy.	Pounds Avoirdupois.	Kilograms.	Long Tons.
Grains......	0.000 000	$\bar{2}$.811 575	$\bar{3}$.357 935	$\bar{4}$.240 549	$\bar{4}$.155 336	$\bar{5}$.811 575	....
Grams......	1.188 422	0.000 000	$\bar{2}$.547 405	$\bar{3}$.428 135	$\bar{3}$.343 212	$\bar{3}$.000 000	....
Oz. Avd.....	2.640 978	1.452 553	0.000 000	$\bar{2}$.880 528	$\bar{2}$.795 880	$\bar{2}$.452 553	$\bar{5}$.447 158
Lbs. Troy...	3.760 422	2.572 000	1.119 454	0.000 000	$\bar{1}$.915 324	$\bar{1}$.572 000	$\bar{4}$.564 666
Lbs. Avd....	3.845 098	2.656 676	1.204 120	0.084 683	0.000 000	$\bar{1}$.656 676	$\bar{4}$.650 308
Kilograms.	4.188 422	3.000 000	1.547 442	0.428 008	0.343 330	0.000 000	$\bar{4}$.992 995
Long Tons.	7.195 346	6.006 924	4.554 368	3.434 920	3.350 242	3.006 924	0.000 000

MEASURES OF PRESSURE.

NAME OF UNIT.	Atmospheres.	Pounds on Square Inch.	Inches of Mercury.	Feet of Water at 60° F.	Millimeters of Mercury.	Pounds on Square Foot	Kilograms on Square Meter.
Atmospheres	1.	14.7	29.922	33.93	760.000	2 116.000	10 333 000
Pounds on Square Inch	.068 03	1.	2.036	2.309	51.700	143.946	702.925
Inches of Mercury................	.033 42	.491 3	1.	1.134	25.398	70.700	345.331
Feet of Water at 60° F...........	.029 47	.433 2	.881 8	1.	22.399	62.363	304.565
Millimeters of Mercury.........	.001 316	.019 34	.039 37	.044 64	1.	2.784	13.596
Pounds on Square Foot	.000 472 6	.006 947	.014 14	.016 03	.359 2	1.	4.883
Kilograms on Square Meter....	.000 096 77	.001 423	.002 895	.003 283	.073 55	.204 8	1.

LOGARITHMS OF MEASURES OF PRESSURE.

NAME OF UNIT.	Atmospheres.	Pounds on Square Inch.	Inches of Mercury.	Feet of Water at 60° F.	Millimeters of Mercury.	Pounds on Square Foot.	Kilograms on Square Meter.
Atmospheres	0.000 000	1.167 317	1.475 991	1.530 584	2.880 814	3.325 516	4.014 226
Pounds on Square Inch	$\bar{2}$.832 700	0.000 000	0.308 778	0 361 897	1.713 491	2.158 200	2.846 909
Inches of Mercury................	$\bar{2}$.524 006	$\bar{1}$.691 347	0.000 000	0.054 613	1.404 800	1.849 419	2.538 238
Feet of Water at 60° F...........	$\bar{2}$.469 380	$\bar{1}$.636 688	$\bar{1}$.945 370	0 000 000	1.350 229	1.794 927	2.483 679
Millimeters of Mercury.........	$\bar{3}$.119 256	$\bar{2}$.286 456	$\bar{2}$.595 165	$\bar{2}$.649 735	0.000 000	0.444 669	1.133 413
Pounds on Square Foot..........	$\bar{4}$.674 494	$\bar{3}$.841 797	$\bar{3}$.150 449	$\bar{2}$.204 934	$\bar{1}$ 555 336	0.000 000	0.688 687
Kilograms on Square Meter....	$\bar{5}$.985 741	$\bar{3}$.153 205	$\bar{3}$.461 649	$\bar{3}$.516 271	$\bar{2}$.866 642	$\bar{1}$.311 330	0.000 000

TELEGRAPH KNOTS INTO MILES.

Table for the Conversion of Knots of 2029 Yards into Statute Miles of 1760 Yards.

Knots.	0	1	2	3	4	5	6	7	8	9
0		1.152 8	2.305 7	3.458 5	4.611 4	5.764 2	6.917 0	8.069 9	9.212 7	10.375 6
10	11.528 4	12.681 2	13.834 1	14.986 9	16.139 8	17.292 6	18.445 4	19.598 3	20.751 1	21.904 0
20	23.056 8	24.209 6	25.362 5	26.515 3	27.668 2	28.821 0	29.973 8	31.126 7	32.279 5	33.432 4
30	34.585 2	35.738 0	36.890 9	38.043 7	39.196 6	40.349 4	41.502 2	42.655 1	43.807 9	44.960 8
40	46.113 6	47.266 4	48.419 3	49.572 1	50.725 0	51.877 8	53.030 6	54.183 5	55.336 3	56.489 2
50	57.642 0	58.794 8	59.947 7	61.100 5	62.253 4	63.406 2	64.559 0	65.711 9	66.864 7	68.017 6
60	69.170 4	70.323 2	71.476 1	72.628 9	73.781 8	74.934 6	76.087 4	77.240 3	78.393 1	79.546 0
70	80.698 8	81.851 6	83.004 5	84.157 3	85.310 2	86.463 0	87.615 8	88.768 7	89.921 5	91.074 4
80	92.227 2	93.380 0	94.532 9	95.685 7	96.838 6	97.991 4	99.144 2	100.297 1	101.449 9	102.602 8
90	103.755 6	104.908 4	106.061 3	107.214 1	108.367 0	109.519 8	110.672 6	111.825 5	112.978 3	114.131 2

DECIMAL EQUIVALENTS OF PARTS OF AN INCH.

$\frac{1}{16}$ths.	$\frac{1}{32}$ds.	$\frac{1}{64}$ths.	Mils.	$\frac{1}{16}$ths.	$\frac{1}{32}$ds.	$\frac{1}{64}$ths.	Mils.
		1	15.625			33	515.625
	1	2	31.250		17	34	531.250
		3	46.875			35	546.875
1	2	4	62.500	9	18	36	562.500
		5	78.125			37	578.125
	3	6	93.750		19	38	593.750
		7	109.375			39	609.375
2	4	8	125.000	10	20	40	625.000
		9	140.625			41	640.625
	5	10	156.250		21	42	656.250
		11	171.875			43	671.875
3	6	12	187.500	11	22	44	687.500
		13	203.125			45	703.125
	7	14	218.750		23	46	718.750
		15	234.375			47	734.375
4	8	16	250.000	12	24	48	750.000
		17	265.625			49	765.625
	9	18	281.250		25	50	781.250
		19	296.875			51	796.875
5	10	20	312.500	13	26	52	812.500
		21	328.125			53	828.125
	11	22	343.750		27	54	843.750
		23	359.375			55	859.375
6	12	24	375 000	14	28	56	875.000
		25	390.625			57	890.625
	13	26	406.250		29	58	906.250
		27	421.875			59	921.875
7	14	28	437.500	15	30	60	937.500
		29	453.125			61	953.125
	15	30	468.750		31	62	968.750
		31	484.375			63	984.375
8	16	32	500.000	16	32	64	1000.000

TABLE OF THE DENSITY AND VOLUME OF WATER FROM 9° C. TO 100° C.

According to M. Despretz (the density and volume at 4° taken as unity).

Temperature.	Volume.	Density.	Temperature.	Volume.	Density.
—9°	1.001 631 1	0.998 371	15°	1.000 875 1	0.999 125
—8	1.001 373 4	0.998 628	16	1.001 021 5	0.998 979
—7	1.001 135 4	0.998 865	17	1.001 206 7	0.998 794
—6	1.000 918 4	0.999 082	18	1.001 39	0.998 612
—5	1.000 698 7	0.999 302	19	1.001 58	0.998 422
—4	1.000 561 9	0.999 437	20	1.001 79	0.998 213
—3	1.000 422 2	0.999 577	21	1.002 00	0.998 004
—2	1.000 307 7	0.999 692	22	1.002 22	0.997 784
—1	1.000 213 8	0.999 786	23	1.002 44	0.997 566
0	1.000 126 9	0.999 873	24	1.002 71	0.997 297
1	1.000 073 0	0.999 927	25	1.002 93	0.997 078
2	1.000 033 1	0.999 966	26	1.003 21	0.996 800
3	1.000 008 3	0.999 999	27	1.003 45	0.996 562
4	1.000 000 0	1.000 000	28	1.003 74	0.996 274
5	1.000 008 2	0.999 999	29	1.004 03	0.995 986
6	1.000 030 9	0.999 969	30	1.004 33	0.995 688
7	1.000 070 8	0.999 929	40	1.007 73	0.992 329
8	1.000 121 6	0.999 878	50	1.012 05	0.988 093
9	1.000 187 9	0.999 812	60	1.016 98	0.983 303
10	1.000 268 4	0.999 731	70	1.022 55	0.977 947
11	1 000 359 8	0.999 640	80	1.028 85	0.971 959
12	1.000 472 4	0.999 527	90	1.035 66	0.965 567
13	1.000 586 2	0.999 414	100	1.043 15	0.958 634
14	1.000 714 6	0.999 285			

THE COMPARISON OF DIFFERENT THERMOMETERS.

Two temperatures may be easily obtained and are constant when produced, namely, the boiling point of water and the melting point of ice.

On the scale of the Reaumur thermometer the boiling point is called 80° and the melting point of ice 0°. Zero is also the same point on the Centigrade scale, but the boiling point is placed at 100°. On the Fahrenheit scale the melting point of ice is placed at 32°, 0° being considered at the time the lowest obtainable temperature, and the boiling point is called 212°.

Therefore, if we wish to convert a temperature on any one of these scales to the equivalent temperature on another, we use one of the following formulæ:

$$t^\circ \text{ R.} = \tfrac{5}{4}\, t^\circ \text{ C.} = 32 + \tfrac{9}{4}\, t^\circ \text{ F.}$$
$$t^\circ \text{ C.} = \tfrac{4}{5}\, t^\circ \text{ R.} = 32 + \tfrac{9}{5}\, t^\circ \text{ F.}$$
$$t^\circ \text{ F.} - 32^\circ \text{ F.} = \tfrac{4}{9}\, t^\circ \text{ R.} = \tfrac{5}{9}\, t^\circ \text{ C.}$$

TABLE OF COMPARISON OF DIFFERENT THERMOMETERS.

Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.	Reaumur.	Centigrade.
212	80.0	100.0	192	71.1	88.8	172	62.2	77.7	152	53.3	66.6
211	79.5	99.4	191	70.6	88.3	171	61.7	77.2	151	52.8	66.1
210	79.1	98.8	190	70.2	87.7	170	61.3	76.6	150	52.4	65.5
209	78.6	98.3	189	69.7	87.2	169	60.8	76.1	149	52.0	65.0
208	78.2	97.7	188	69.3	86.6	168	60.4	75.5	148	51.5	64.4
207	77.7	97.2	187	68.8	86.1	167	60.0	75.0	147	51.1	63.8
206	77.3	96.6	186	68.4	85.5	166	59.5	74.4	146	50.6	63.3
205	76.8	96.1	185	68.0	85.0	165	59.1	73.8	145	50.2	62.7
204	76.4	95.5	184	67.5	84.4	164	58.6	73.3	144	49.7	62.2
203	76.0	95.0	183	67.1	83.8	163	58.2	72.7	143	49.3	61.6
202	75.5	94.4	182	66.6	83.3	162	57.7	72.2	142	48.8	61.1
201	75.1	93.8	181	66.2	82.7	161	57.3	71.6	141	48.4	60.5
200	74.6	93.3	180	65.7	82.2	160	56.8	71.1	140	48.0	60.0
199	74.2	92.7	179	65.3	81.6	159	56.4	70.5	139	47.5	59.4
198	73.7	92.2	178	64.8	81.1	158	56.0	70.0	138	47.1	58.8
197	73.3	91.6	177	64.4	80.5	157	55.5	69.4	137	46.6	58.3
196	72.8	91.1	176	64.0	80.0	156	55.1	68.8	136	46.2	57.7
195	72.4	90.5	175	63.5	79.4	155	54.6	68.3	135	45.7	57.2
194	72.0	90.0	174	63.1	78.8	154	54.2	67.7	134	45.3	56.6
193	71.5	89.4	173	62.6	78.3	153	53.7	67.2	133	44.8	56.1

TABLE OF COMPARISON OF DIFFERENT THERMOMETERS—*Continued.*

Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.	Reaumur.	Centigrade.	Fahrenheit.	Reaumur.	Centigrade.
132	44.4	55.5	93	27.1	33.8	54	9.7	12.2	15	—7.5	—9.5
131	44.0	55.0	92	26.6	33.3	53	9.3	11.6	14	—8.0	—10.0
130	43.5	54.4	91	26.2	32.7	52	8.8	11.1	13	—8.4	—10.5
129	43.1	53.8	90	25.7	32.2	51	8.4	10.5	12	—8.8	—11.1
128	42.6	53.3	89	25.3	31.6	50	8.0	10.0	11	—9.3	—11.6
127	42.2	52.7	88	24.8	31.1	49	7.5	9.4	10	—9.7	—12.2
126	41.7	52.2	87	24.4	30.5	48	7.1	8.8	9	—10.2	—12.7
125	41.3	51.6	86	24.0	30.0	47	6.6	8.3	8	—10.6	—13.3
124	40.8	51.1	85	23.5	29.4	46	6.2	7.7	7	—11.1	—13.8
123	40.4	50.5	84	23.1	28.8	45	5.7	7.2	6	—11.5	—14.4
122	40.0	50.0	83	22.6	28.3	44	5.3	6.6	5	—12.0	—15.0
121	39.5	49.4	82	22.2	27.7	43	4.8	6.1	4	—12.4	—15.5
120	39.1	48.8	81	21.7	27.2	42	4.4	5.5	3	—12.8	—16.1
119	38.6	48.3	80	21.3	26.6	41	4.0	5.0	2	—13.3	—16.6
118	38.2	47.7	79	20.8	26.1	40	3.5	4.4	1	—13.7	—17.2
117	37.7	47.2	78	20.4	25.5	39	3.1	3.8	0	—14.2	—17.7
116	37.3	46.6	77	20.0	25.0	38	2.6	3.3	—1	—14.6	—18 3
115	36.8	46.1	76	19.5	24.4	37	2.2	2.7	—2	—15.1	—18.8
114	36.4	45.5	75	19.1	23.8	36	1.7	2.2	—3	—15.5	—19.4
113	36.0	45.0	74	18.6	23.3	35	1.3	1.6	—4	—16.0	—20.0
112	35.5	44.4	73	18.2	22.7	34	0.8	1.1	—5	—16.4	—20.5
111	35.1	43.8	72	17.7	22.2	33	0.4	0.5	—6	—16.8	—21.1
110	34.6	43.3	71	17.3	21.6	32	0.0	0.0	—7	—17.3	—21.6
109	34.2	42.7	70	16.8	21.1	31	—0.4	—0.5	—8	—17.7	—22.2
108	33.7	42.2	69	16.4	20.5	30	—0.8	—1.1	—9	—18.2	—22.7
107	33.3	41.6	68	16.0	20.0	29	—1.3	—1.6	—10	—18.6	—23.3
106	32.8	41.1	67	15.5	19.4	28	—1 7	—2.2	—11	—19.1	—23.8
105	32.4	40.5	66	15.1	18.8	27	—2.2	—2.7	—12	—19.5	—24.4
104	32.0	40.0	65	14.6	18.3	26	—2.6	—3.3	—13	—20.0	—25.0
103	31.5	39.4	64	14.2	17.7	25	—3.1	—3.8	—14	—20.4	—25.5
102	31.1	38.8	63	13.7	17.2	24	—3.5	—4.4	—15	—20.8	—26.1
101	30.6	38.3	62	13.3	16 6	23	—4.0	—5.0	—16	—21.3	—26.6
100	30.2	37.7	61	12.8	16.1	22	—4.4	—5.5	—17	—21.7	—27.2
99	29.7	37.2	60	12.4	15.5	21	—4.8	—6.1	—18	—22.2	—27.7
98	29.3	36.6	59	12.0	15.0	20	—5.3	—6.6	—19	—22.6	—28.3
97	28.8	36.1	58	11.5	14.4	19	—5.7	—7.2	—20	—23.1	—28.8
96	28.4	35.5	57	11.1	13.8	18	—6.2	—7.7			
95	28.0	35.0	56	10.6	13.3	17	—6.6	—8.3			
94	27.5	34.4	55	10.2	12.7	16	—7.1	—8.8			

TABLES OF SPECIFIC GRAVITIES.

METALS.

Metal.	Specific Gravity.	Weight per Cubic Foot.	Specific Heat.	Melting Point in Degrees Fahr.
Aluminum, Cast	2.5[1]	156.06	.214 3	....
" Hammered.	2.67[1]	166.67	....	....
Antimony	6.702[2]	418.37	.050 8	810.
Arsenic	5.763[2]	359.76	.081 4	365.
Barium	4.[3]	249.70	....	....
Bismuth	9.822[2]	613.14	.030 8	497.
Cadmium	8.604[5]	537.10	.056 7	500.
Calcium	1.566[4]	97.76	....	....
Chromium	7.3[6]	455.70	....	....
Cobalt	8.6	536.86	.107 0	....
Copper	8.895[7]	555.27	.095 1	1 996.
" Rolled	8.878[2]	554.21	....	....
" Cast	8.788[2]	548.59	....	....
" Drawn	8.946 3[8]	558.47	....	....
" Hammered	8.958 7[8]	559.25	....	....
" Pressed	8.931[9]	557.52	....	....
" Electrolytic	8.914[9]	556.46	....	....
Gold	19.258[2]	1 202.18	.032 4	2 016.
Iron, Bar	7.483 9	467.18	.130	2 786.
" Wrought	7.79	486.29	.113	3 286.
Steel	7.85	490.03	.116	3 286.
Lead	11.445[10]	714.45	.031 4	612.
Magnesium	2.24[11]	139.83	.249 9	....
Manganese	6.9[12]	430.73	.114	3 000.
Mercury	13.568[13]	846.98	.031 9	—38
Nickel	7.832	488.91	.109 1	280 0.
Platinum	20.3[2]	1 267.22	.032 4	328 6.
Potassium	.865[14]	54.00	.169 6	136.
Silver	10.522[11]	656.84	.057 0	1 873.
Sodium	.972[14]	60.68	.293 4	194.
Strontium	2.504[4]	156.31	....	....
Tin	7.291[2]	455.14	.056 2	442.
Zinc	6.861[2]	428.29	.095 5	773.

1. Wohler.
2. Brisson.
3. Clarke.
4. Matthiessen.
5. Stromeyer.
6. Bunsen.
7. Hatchett.
8. Brezenius.
9. Marchand & Scheerer.
10. Musschenbroek.
11. Playfair & Joule.
12. Bergman.
13. Watts' Dictionary.
14. Guy-Lussac & Thenard.

LIQUIDS.

Liquid.	Specific Gravity.	Temperature.
Alcohol	0.815 71	At 50° F.
Benzine	0.883	At 59° F.
Chloroform	1.491	At 62.6° F.
Carbon Bisulphide	1.293 1	At 32° F.
Ether	0.720 4	At 60.8° F.
Glycerine	1.263 6	At 59° F.
Hydrochloric Acid	1.270	....
Mercury	13.596	At 32° F.
Nitric Acid	1.552	At 59° F.
Oil of Turpentine	0.855 to 0.864	At 68° F.
Linseed Oil	0.940	....
Olive Oil	0.915	....
Sulphuric Acid	1.854	At 32° F.

GASES

Gas.	At 0° C. and 760 mm. pressure compared to water.	Compared to air at similar pressure and Temperature.
Air	0.001 292 8	1.000 00
Oxygen	0.001 429 3	1.105 63
Nitrogen	0.001 255 7	0.971 37
Hydrogen	0.000 089 54	0.069 26
Carbonic Dioxide	0.001 976 7	1.529 10
Mixed Gases from Electrolysis of Water	0.000 536 1	0.414 72
Aqueous Vapor	....	0.623 00

WEIGHTS OF SUBSTANCES PER CUBIC FOOT.

Name of Substance.	Average Weight. Pounds.
Asphaltum	87.
Brick, common, hard	125.
Brickwork, pressed brick	140.
" ordinary	112.
Coal, Anthracite, solid, of Pennsylvania	93.
" " broken, loose	54.
" Bituminous, solid	84.
" " broken, loose	49.
Coke, loose, of good coal	62.
Cork	12.4
Earth, common loam, dry, loose	76.
" " " " moderately rammed.	95.
" as a soft, flowing mud	108.
Gneiss, common	168.
Granite	170.
Glass, Crown	168.5
" flint	218.3
Ice at 0	57.2
Lime, thoroughly shaken	75.
Masonry, of granite or limestone, well dressed	165.
Mortar, hardened	103.
Mud, dry, close	80 to 1
Quartz	165.4
Sulphur	131.0
Wax	58.7
Wood, ebony	74.9
" birch	43.7
" oak	46.8
" pine	31.2

PROPERTIES OF COPPER WIRE.

By F. A. C. PERRINE, D.Sc.

Early in 1889 I found it necessary to revise certain tables of the resistance of copper wires in our catalogues, and to adopt a standard of conductivity which should represent the best results which had been obtained; on investigation it was found that the most reliable results were those to be found in Fleeming Jenkins' tabulation of Dr. Matthiessen's experiments, and from which I adopted as our standard the case "one mil foot at 0° C. measures 9.718 B. A. ohms." The most accurate temperature correction I found to be expressed in the formula

$$\text{Conductivity at } C = 1 - .0038701\, t + .000009009\, t^2$$

and the specific gravity was taken as 8.9, water being at its greatest density 62.425 pounds per cubic foot.

On September 16th, 1890, the Standard Wiring Table Committee of the American Institute of Electrical Engineers presented a report in which they have recommended practically the same results, as follows:

"The subject of Matthiessen's standard alone is so confused and involved, and the discrepancies in regard to it are so great between the best authorities that the Committee has devoted its attention almost entirely to this subject up to the present time.

"A very thorough investigation of Matthiessen's work has been made by a sub-committee, consisting of Professor William E. Geyer, George B. Prescott, Jr., and the Chairman, Francis B. Crocker, and the conclusion has been reached that the most correct and satisfactory 'Matthiessen's Standard,' and the one which we now recommend for general adoption, is stated as follows: A soft copper wire one meter long and one millimeter in diameter ('meter-millimeter') has an electrical resistance of .02057 B. A. units at 0° Centigrade.

"From this the resistance of a soft copper wire one foot long and one-thousandth of an inch in diameter ('mil-foot') is found to be 9.720 B. A. units at 0° C.

"In order to convert these values into legal ohms, we may assume one B. A. unit to be equal to .9889 legal ohms, and the

meter-millimeter value then becomes .02034 legal ohms, and the mil-foot value becomes 9.612 legal ohms.

"The resistance of copper at temperature other than 0° Centigrade may be determined by using Matthiessen's formula $C_t = C_o (1 - .00387\,t + .000009009\,t^2)$ in which C_t is the conductivity at the given temperature, C_o is the conductivity at 0° and t is the given temperature in degrees Centigrade. It should be carefully noted, however, that this formula refers to *conductivity.* Therefore, in order to apply it to resistance, it is necessary to take the reciprocal, and this should not be done by merely changing signs, which is not mathematically correct, although usually given in that way. The correct modification of Matthiessen's formula, when referred to resistance, is

$$R_t = R_o (1 + .00387\,t + .00000597\,t^2$$

"The sub-committee, after careful consideration, came to the conclusion that Matthiessen's 'mile standard' (one statute mile of copper wire $\frac{1}{16}$-inch in diameter has a resistance of 13.59 B. A. units at 15.5° C.) is not the correct one, although very commonly used. Matthiessen himself did not place much confidence in this 'mile standard.' The Committee, acting under instructions from a meeting of the Institute, held September 16th, 1890, has based all standards and values in this report upon soft or annealed copper since its properties are reasonably constant and reliable. Whereas, the Committee has purposely excluded from its recommendations all standards and values based upon hard copper, although several were given by Matthiessen, because the hardness of copper is merely relative, and the resistance of hard copper may vary between wide and uncertain limits depending upon the *degree* of hardness.

"As to the fact often brought up, that copper may be found which tests one or two per cent higher conductivity or less resistance than Matthiessen's standard, we are of the opinion that this is no real objection, provided the value of the standard is definite and generally accepted. A standard which is not the highest attainable value may even be considered an advantage, since the average commercial wires will approximate to it more closely.

"Although we believe the standard we recommend will answer the purpose temporarily and probably permanently, neverthe-

less, we think that if a thoroughly correct and complete redetermination of the standard resistance of copper could be accomplished, it would be a benefit to electrical science and industry. Favorable offers in this direction have already been received by this Committee from Johns Hopkins University, Cornell University, and Columbia College, and it is likely that this redetermination may be undertaken.

"The following statement of the most important and reliable figures and facts given by Matthiessen will serve to show the derivation of the standard which we recommend.

"A hard-drawn copper wire 1 meter long weighing 1 gram ('meter-gram') has a resistance of .1469 B. A. units at the temperature of 0° Centigrade.*

"Matthiessen also gives the resistance of a hard-drawn copper wire 1 meter long and 1 millimeter in diameter ('meter-millimeter') as .02104 B. A. units at 0° C.*

"This implies a specific gravity of 8.89 for the copper used by Matthiessen, but unfortunately he neglected to actually determine the specific gravity.

"Matthiessen's figures for relative conducting power are: †

Silver	100
Hard or unannealed copper	99.95
Soft or annealed copper	102.21

"From these the resistance of Matthiessen's hard copper is found to be 1.0226 times that of soft copper, therefore the resistance of a soft copper wire 1 meter long and 1 millimeter diameter ('meter-millimeter') is .02057 B. A. units at 0° C., which is the standard we recommend.

"From this the resistance of 1 cubic centimeter of soft copper is found to be .000001616 B. A. units at 0° C.

"And the resistance of soft copper wire 1 foot long and .001 inch in diameter ('mil-foot') is 9.720 B. A. units at 0° C.

"Taking one B. A. unit as .9889 legal ohms any of the above values may be converted into legal ohms. To find the conductivity of copper at temperatures other than 0° C., Matthiessen's formula may be used, viz.:

$$C_t = C_o\,(1 - .00387\,t + .000009009\,t^2) \text{ or}$$
$$R_t = R_o\,(1 + .00387\,t + .00000597\,t^2)$$

*Philosophical Magazine, May, 1865.

†Philosophical Transactions, 1864.

TABLE.

Standard Resistance at 0° C. of	B. A. U.	Legal Ohms.
"Meter-millimeter," Soft Copper....................	.02057	.02034
"Cubic Centimeter," " "	.000001616	.000001598
"Mil-foot," " "	9.720	9.612

"One mil-foot of soft copper at 10.22° C. or 50.4° F. has

Standard resistance of exactly..........................	10	legal ohms.	
Same at 15.5° C. or 59.9° F..........................	10.20	"	"
" 23.9° C. or 75° F..........................	10.53	"	"

"F. B. CROCKER,
"*Chairman.*"

Shortly after this report was presented, I took an average of my tests on 682 samples, the result of a year's work, and found that the average conductivity of the whole number was 98.98 per cent., or practically 99 per cent. All of this copper was from Calumet and Hecla bars rolled and drawn at our own mill at Trenton, and it represents daily practice, since no selection was made of the samples, and all results are included in the average.

That commercial copper should give 99 per cent. the conductivity of a standard, I believe to be one of the strongest arguments in favor of that standard for the practical electrical engineer, since it will allow the use of tables calculated therefrom without correction, one per cent. being well within the limits of practice in manufacture.

The tables in this book, having been calculated before this report was presented, have not been corrected to the value "one mil-foot at 0° C. measures 9.720 B. A. units," since the value used varies from it by only .02 per cent.

RESISTANCE OF 1 MIL FOOT OF COPPER WIRE AT DIFFERENT TEMPERATURES FAHRENHEIT.

Temperature in Degrees.	B. A. Units.	Legal Ohms.	Temperature in Degrees.	B. A. Units.	Legal Ohms.	Temperature in Degrees.	B. A. Units.	Legal Ohms.
0	9.067 73	8.967 07	34	9.759 85	9.651 52	68	10.493 37	10.376 89
1	9.087 49	8.986 62	35	9.780 84	9.672 27	69	10.515 57	10.398 84
2	9.107 29	9.006 20	36	9.801 86	9.693 06	70	10.537 80	10.420 83
3	9.127 13	9.025 82	37	9.822 91	9.713 88	71	10.560 08	10.442 86
4	9.147 01	9.045 47	38	9.844 00	9.734 73	72	10.582 38	10.464 92
5	9.166 91	9.065 16	39	9.865 13	9.755 63	73	10.604 73	10.487 02
6	9.186 86	9.084 89	40	9.886 29	9.776 55	74	10.627 11	10.509 15
7	9.206 84	9.104 64	41	9.907 49	9.797 52	75	10.649 52	10.531 31
8	9.226 86	9.124 44	42	9.928 72	9.818 51	76	10.671 97	10.553 51
9	9.246 91	9.144 27	43	9.949 99	9.839 55	77	10.694 46	10.575 75
10	9.267 00	9.164 13	44	9.971 30	9.860 62	78	10.716 98	10.598 02
11	9.287 12	9.184 03	45	9.992 64	9.881 72	79	10.739 54	10.620 33
12	9.307 28	9.203 97	46	10.014 02	9.902 86	80	10.762 14	10.642 68
13	9.327 48	9.223 94	47	10.035 43	9.924 03	81	10.784 77	10.665 05
14	9.347 71	9.243 95	48	10.056 88	9.945 25	82	10.807 43	10.687 47
15	9.367 98	9.263 99	49	10.078 36	9.966 49	83	10.830 13	10.709 92
16	9.388 28	9.284 07	50	10.099 88	9.987 77	84	10.852 87	10.732 40
17	9.408 62	9.304 18	51	10.121 44	10.009 09	85	10.875 64	10.754 92
18	9.428 99	9.324 33	52	10.143 03	10.030 44	86	10.898 45	10.777 48
19	9.449 40	9.344 51	53	10.164 66	10.051 83	87	10.921 30	10.800 07
20	9.469 85	9.364 73	54	10.186 32	10.073 25	88	10.944 18	10.822 70
21	9.490 33	9.384 99	55	10.208 02	10.094 71	89	10.967 09	10.845 36
22	9.510 85	9.405 28	56	10.229 75	10.116 20	90	10.990 05	10.868 06
23	9.531 40	9.425 60	57	10.251 53	10.137 73	91	11.013 04	10.890 79
24	9.551 99	9.445 96	58	10.273 33	10.159 30	92	11.036 06	10.913 56
25	9.572 62	9.466 36	59	10.295 17	10.180 90	93	11.059 12	10.936 36
26	9.593 28	9.486 79	60	10.317 05	10.202 53	94	11.082 21	10.959 20
27	9.613 97	9.507 26	61	10.338 97	10.224 20	95	11.105 35	10.982 08
28	9.634 71	9.527 76	62	10.360 92	10.245 91	96	11.128 51	11.004 99
29	9.655 48	9.548 30	63	10.382 90	10.267 65	97	11.151 72	11.027 93
30	9.676 28	9.568 87	64	10.404 92	10.289 43	98	11.174 95	11.050 91
31	9.697 12	9.589 48	65	10.426 98	10.311 24	99	11.198 23	11.073 93
32	9.718 00	9.610 13	66	10.449 07	10.333 09	100	11.221 54	11.096 98
33	9.738 91	9.630 80	67	10.471 20	10.354 97			

TABLE OF SQUARES

Number of Wire Gauge.	Roebling. Diameter in Mils.	Roebling. Area. Circular Mils.	Roebling. Area. Square Mils.	Brown and Sharpe. Diameter in Mils.	Brown and Sharpe. Area. Circular Mils.	Brown and Sharpe. Area. Square Mils.
000000	460.	211 600.	166 190.640 0	....	....	....
00000	430.	184 900.	145 220.460 0	....	....	....
0000	393.	154 449.	121 304.244 6	460.000	211 600.0	166 191.
000	362.	131 044.	102 921.957 6	409.640	167 805.0	131 790.
00	331.	109 561.	86 049.209 4	364.800	133 079.2	104 520.
0	307.	94 249.	74 023.164 6	324.860	105 534.0	82 886.
1	283.	80 089.	62 901.900 6	289.300	83 694.0	65 733.
2	263.	69 169.	54 325.332 6	257.630	66 373.0	52 129.
3	244.	59 536.	46 759.574 4	229.420	52 633.4	41 338.
4	225.	50 625.	39 760.875 0	204.310	41 742.5	32 784.
5	207.	42 849.	33 653.604 6	181.940	33 102.3	25 998.
6	192.	36 864.	28 952.985 6	162.020	26 250.5	20 617.
7	177.	31 329.	24 605.796 6	144.280	20 817.0	16 349.
8	162.	26 244.	20 612.037 6	128.490	16 509.0	12 967.
9	148.	21 904.	17 203.401 6	114.430	13 094.0	10 284.
10	135.	18 225.	14 313.915 0	101.890	10 381.0	8 153.6
11	120.	14 400.	11 309.760 0	90.742	8 234.1	6 467.1
12	105.	11 025.	8 659.035 0	80.808	6 529.9	5 128.6
13	92.	8 464.	6 647.625 6	71.961	5 178.4	4 067.1
14	80.	6 400.	5 026.560 0	64.084	4 106.8	3 225.4
15	72.	5 184.	4 071.513 6	57.068	3 256.8	2 557.8
16	63.	3 969.	3 117.252 6	50.820	2 582.7	2 028.4
17	54.	2 916.	2 290.226 4	45.257	2 048.2	1 608.6
18	47.	2 209.	1 734.948 6	40.303	1 624.3	1 275.7
19	41.	1 681.	1 320.257 4	35.890	1 288.1	1 011.7
20	35.	1 225.	962.115 0	31.961	1 021.5	802.28
21	32.	1 024.	804.249 6	28.462	810.08	636.25
22	28.	784.	615.753 6	25.347	642.47	504.59
23	25.	625.	490.875 0	22.571	509.45	400.12
24	23.	529.	415.476 6	20.100	404.01	317.31
25	20.	400.	314.160 0	17.900	320.41	251.65
26	18.	324.	254.469 6	15.940	254.08	199.56
27	17.	289.	226.980 6	14.195	201.50	158.26
28	16.	256.	201.062 4	12.641	159.79	125.50
29	15.	225.	176.715 0	11.257	126.72	99.53
30	14.	196.	153.938 4	10.025	100.50	78.93
31	13.5	182.25	143.139 2	8.928	79.71	62.60
32	13.0	169.00	132.732 6	7.950	63.20	49.63
33	11.0	121.00	95.033 4	7.080	50.13	39.37
34	10.0	100.00	78.540 0	6.304	39.74	31.21
35	9.5	90.25	70.882 3	5.614	31.52	24.75
36	9.0	81.00	63.617 4	5.000	25.00	19.64

AND AREAS.

Birmingham or Stubs. Diameter in Mils.	Area. Circular Mils.	Square Mils.	English Legal Standard. Diameter in Mils.	Area. Circular Mils.	Square Mils.	Number of Wire Gauge.
......	....	....	464.	215 296.	169 093.478 4	000000
......	....	....	432.	186 624.	146 574.489 6	00000
454.	206 116.	161 883.506 4	400.	160 000.	125 664.000 0	0000
425.	180 625.	141 862.875 0	372.	138 384.	108 686.793 6	000
380.	144 400.	113 411.760 0	348.	121 104.	95 115.081 6	00
340.	115 600.	90 792.240 0	324.	104 976.	82 448.150 4	0
300.	90 000.	70 686.000 0	300.	90 000.	70 686.000 0	1
284.	80 656.	63 347.222 4	276.	76 176.	59 828.630 4	2
259.	67 081.	52 685.417 4	252.	63 504.	49 876.041 6	3
238.	56 644.	44 488.197 6	232.	53 824.	42 273.369 6	4
220.	48 400.	38 013.360 0	212.	44 944.	35 299.017 6	5
203.	41 209.	32 365.548 6	192.	36 864.	28 952.985 6	6
180.	32 400.	25 446.960 0	176.	30 976.	24 328.550 4	7
165.	27 225.	21 382.515 0	160.	25 600.	20 106.240 0	8
148.	21 904.	17 203.401 6	144.	20 736.	16 286.054 4	9
134.	17 956.	14 102.642 4	128.	16 384.	12 867.993 6	10
120.	14 400.	11 309.760 0	116.	13 456.	10 568.342 4	11
109.	11 881.	9 331.337 4	104.	10 816.	8 494.886 4	12
95.	9 025.	7 088.235 0	92.	8 464.	6 647.625 6	13
83.	6 889.	5 410.620 6	80.	6 400.	5 026.560 0	14
72.	5 184.	4 071.513 6	72.	5 184.	4 071.513 6	15
65.	4 225.	3 318.315 0	64.	4 096.	3 216.998 4	16
58.	3 364.	2 642.085 6	56.	3 136.	2 463.014 4	17
49.	2 401.	1 885.745 4	48.	2 304.	1 809.561 6	18
42.	1 764.	1 385.445 6	40.	1 600.	1 256.640 0	19
35.	1 225.	962.115 0	36.	1 296.	1 017.878 4	20
32.	1 024.	804.249 6	32.	1 024.	804.249 6	21
28.	784.	615.753 6	28.	784.	615.753 6	22
25.	625.	490.875 0	24.	576.	452.390 4	23
22.	484.	380.133 6	22.	484.	380.133 6	24
20.	400.	314.160 0	20.	400.	314.160 0	25
18.	324.	254 469 6	18.	324.	254.469 6	26
16.	256.	201.062 4	16.4	268.96	211.241 184	27
14.	196.	153.938 4	14.8	219.04	172.034 016	28
13.	169.	132.732 6	13.6	184.96	145.267 584	29
12.	144.	113.097 6	12.4	153.76	120.763 104	30
10.	100.	78.540 0	11.6	134.56	105.683 424	31
9.	81.	63.617 4	10.8	116.64	91.609 056	32
8.	64.	50.265 6	10.0	100.00	78.540 900	33
7.	49.	38.484 6	9.2	84 64	66.476 256	34
5.	25.	19.635 0	8.4	70.56	55.417 824	35
4.	16.	12.566 4	7.6	57.76	45.364 704	36

RESISTANCE PER 1,000

Number of Wire Gauge.	Roebling.				Brown and Sharpe.			
	55° Fahr.		70° Fahr.		55° Fahr.		70° Fahr.	
	B. A. Units.	Legal Ohms.	B. A. Units.	Legal Ohms.	B. A. Units.	Legal Ohms.	B. A. Units.	Legal Ohms.
000000	.048 24	.047 71	.049 81	.049 25	....	....	....	....
00000	.055 21	.054 59	.056 99	.056 36	....	....	....	....
0000	.066 09	.065 36	.068 23	.067 47	.048 24	.047 72	.049 81	.049 25
000	.077 90	.077 03	.080 41	.079 52	.060 83	.060 16	.062 80	.062 10
00	.093 17	.092 14	.096 18	.095 11	.076 71	.075 85	.079 18	.078 31
0	.108 3	.107 1	.111 8	.110 6	.096 73	.095 66	.099 85	.098 74
1	.127 4	.126 0	.131 6	.130 1	.122 0	.120 6	.125 9	.124 2
2	.147 6	.145 9	.152 3	.150 6	.153 8	.152 1	.158 7	.157 0
3	.171 5	.169 6	.177 0	.175 0	.193 9	.191 8	.200 2	.198 0
4	.201 6	.199 4	.208 2	.205 8	.244 5	.241 8	.252 5	.249 6
5	.238 2	.235 6	.245 9	.243 2	.308 4	.304 9	.318 3	.314 8
6	.276 9	.273 8	.285 9	.282 7	.388 9	.384 6	.401 4	.397 0
7	.325 8	.322 2	.336 4	.332 7	.490 4	.484 9	.506 1	.500 6
8	.389 0	.384 6	.401 6	.397 1	.618 3	.611 4	.638 2	.631 2
9	.466 0	.460 9	.481 1	.475 8	.779 6	.770 9	.804 6	.795 8
10	.560 1	.553 9	.578 2	.571 8	.983 3	.972 4	1.015	1.040
11	.708 9	.701 0	.731 8	.723 7	1.240	1.260	1.280	1.266
12	.925 9	.915 6	.955 8	.945 2	1.563	1.546	1.614	1.596
13	1.206	1.193	1.245	1.231 0	1.971	1.950	2.035	2.012
14	1.595	1.577	1.646	1.628 0	2.486	2.458	2.566	2.537
15	1.969	1.947	2.033	2.010	3.134	3.100	3.235	3.200
16	2.572	2.543	2.655	2.626	3.952	3.909	4.080	4.035
17	3.501	3.462	3.614	3.574	4.984	4.929	5.145	5.088
18	4.621	4.570	4.771	4.718	6.284	6.215	6.487	6.415
19	6.072	6.005	6.269	6.199	7.925	7.837	8.180	8.089
20	8.333	8.240	8.602	8.507	9.993	9.882	10.31	10.20
21	9.969	9.858	10.29	10.18	12.60	12.46	13.00	12.86
22	13.02	12.87	13.44	13.29	15.89	15.71	16.40	16.22
23	16.33	16.15	16.86	16.67	20.04	19.82	20.68	20.45
24	19.30	19.08	19.92	19.70	25.26	24.99	26.08	25.79
25	25.52	25.24	26.34	26.05	31.86	31.50	32.88	32.52
26	31.51	31.16	32.52	32.16	40.18	39.73	41.47	41.01
27	35.32	34.93	36.46	36.06	50.66	50.10	52.30	51.72
28	39.88	39.43	41.16	40.71	63.88	63.17	65.95	65.21
29	45.37	44.87	46.83	46.31	80.56	79.66	83.16	82.23
30	52.08	51.50	53.76	53.17	101.6	100.5	104.8	103.7
31	56.01	55.39	57.82	57.18	128.1	126.6	132.2	130.7
32	60.40	59.73	62.35	61.66	161.5	159.7	166.8	164.9
33	84.36	83.43	87.09	86.12	203 6	201.4	210.2	207.9
34	102.1	100.9	105.4	104.20	256.9	254.0	265.2	262.2
35	113.1	111.8	116.8	115 5	323.9	320 3	334.4	330.6
36	126.0	124.6	130.1	128.7	408.3	403.8	421.5	416.8

FEET COPPER WIRE.

Birmingham or Stubs.				English Legal Standard.				Number of Wire Gauge.
55° Fahr.		70° Fahr.		55° Fahr.		70° Fahr.		
B. A. Units.	Legal Ohms.	B. A. Units.	Legal Ohms.	B. A. Units.	Legal Ohms.	B. A. Units.	Legal Ohms.	
....	....	....	....	.047 41	.046 89	.048 95	.048 40	000000
....	....	....	....	.054 70	.054 09	.056 47	.055 84	00000
.049 53	.048 97	.051 13	.050 56	.063 80	.063 09	.065 86	.065 13	0000
.056 51	.055 89	.058 33	.057 69	.073 77	.072 95	.076 15	.075 30	000
.070 69	.069 91	.072 98	.072 17	.084 29	.083 36	.087 02	.086 05	00
.088 3	.087 32	.091 16	.090 15	.097 24	.096 16	.100 4	.099 27	0
.113 4	.112 2	.117 1	.115 8	.113 4	.112 2	.117 1	.115 8	1
.126 6	.125 2	.130 7	.129 2	.134 0	.132 5	.138 3	.136 8	2
.152 2	.150 5	.157 1	.155 4	.160 7	.159 0	.166 0	.164 1	3
.180 2	.178 2	.186 0	.184 0	.189 6	.187 5	.195 8	.193 6	4
.210 9	.208 6	.217 7	.215 3	.227 1	.224 6	.234 5	.231 9	5
.247 7	.245 0	.255 8	.252 9	.276 9	.273 8	.285 9	.282 7	6
.315 1	.311 6	.325 3	.321 6	.329 5	.325 9	.340 2	.336 4	7
.374 9	.370 8	.387 1	.382 9	.398 8	.394 3	.411 6	.407 0	8
.466 0	.460 9	.481 1	.475 8	.492 3	.486 8	.508 2	.502 6	9
.568 5	.562 2	.586 9	.580 4	.623 0	.616 1	.643 2	.636 1	10
.708 9	.701 0	.731 8	.723 7	.758 6	.750 2	.783 1	.774 5	11
.859 2	.849 6	.886 9	.877 1	.943 8	.933 3	.974 3	.963 5	12
1.131	1.118	1.168	1.155	1.206	1.193	1.245	1.231	13
1.482	1.465	1.530	1.513	1.595	1.577	1.646	1.628	14
1.969	1.947	2.033	2.010	1.969	1.947	2.033	2.010	15
2.416	2.389	2.494	2.466	2.492	2.464	2.572	2.544	16
3.034	3.001	3.133	3.098	3.256	3 219	3.360	3.323	17
4.252	4.204	4.389	4.340	4.430	4.382	4.574	4 523	18
5.787	5.723	5.974	5.908	6.380	6.309	6.586	6.513	19
8.333	8.240	8.602	8.507	7.876	7.789	8.113	8.041	20
9.969	9.858	10.29	10.18	9.969	9.858	10.29	10.18	21
13.02	12.87	13.44	13.29	13.02	12.87	13.44	13.29	22
16.33	16.15	16.86	16.67	17.72	17.52	18.29	18.09	23
21.09	20.86	21.77	21.53	21.09	20.86	21.77	21.53	24
25.52	25.24	26.34	26.05	25.52	25.24	26.34	26.05	25
31.51	31.16	32.52	32.16	31.51	31.16	32.52	32.16	26
39.88	39.43	41.16	40.71	37.95	37.53	39.18	38.75	27
52.08	51.50	53.76	53.17	46.60	46.08	48.11	47.57	28
60.40	59.73	62.35	61.66	55.19	54.58	56.97	56.34	29
70.89	70.10	73.18	72.37	66.39	65.65	68.54	67.77	30
102.1	100.9	105.4	104.2	75.86	75.02	78.31	77.44	31
126.0	124.6	130.1	128.7	87 52	86.55	90.35	89.34	32
159.5	157.7	164.7	162.8	102.1	100.9	105.4	104.2	33
208.3	206.0	215.1	212.7	120.6	119.3	124.5	123.1	34
408.3	403.7	421.5	416.8	144.7	143.1	149.4	147.7	35
638.0	630.9	658.6	651.3	176.7	174.7	182.5	180.4	36

CONDUCTIVITY OF METALS.

Coëfficients for the temperature: t in degrees Centigrade.

Metal.	Coëfficient.
Silver	$C = 100 - 0.382\,78\,t + 0.000\,984\,8\,t^2$
Copper	$C = 100 - 0.387\,01\,t + 0.000\,900\,9\,t^2$
Gold	$C = 100 - 0.367\,45\,t + 0.000\,844\,3\,t^2$
Zinc	$C = 100 - 0.370\,47\,t + 0.000\,827\,4\,t^2$
Cadmium	$C = 100 - 0.368\,71\,t + 0.000\,757\,5\,t^2$
Tin	$C = 100 - 0.360\,29\,t + 0.000\,613\,6\,t^2$
Lead	$C = 100 - 0.387\,56\,t + 0.000\,914\,6\,t^2$
Arsenic	$C = 100 - 0.389\,96\,t + 0.000\,887\,9\,t^2$
Antimony	$C = 100 - 0.398\,26\,t + 0.001\,036\,4\,t^2$
Bismuth	$C = 100 - 0.352\,16\,t + 0.000\,572\,8\,t^2$
Iron	$C = 100 - 0.511\,82\,t + 0.001\,291\,6\,t^2$

INFLUENCE OF THE TEMPERATURE ON THE RESISTANCE AND THE CONDUCTIVITY OF PURE COPPER.

Temperature, Centigrade.	Resistance.	Conductivity.	Temperature, Centigrade.	Resistance.	Conductivity.	Temperature, Centigrade.	Resistance.	Conductivity.
0	1.000 00	1.000 00	11	1.041 99	0.959 70	22	1.085 53	0.921 21
1	1.003 81	0.996 24	12	1.045 99	0.956 03	23	1.089 54	0.917 82
2	1.007 56	0.992 50	13	1.049 90	0.952 47	24	1.093 56	0.914 45
3	1.011 35	0.988 78	14	1.054 06	0.948 93	25	1.097 63	0.911 10
4	1.015 15	0.985 08	15	1.057 74	0.945 41	26	1.101 61	0.907 76
5	1.018 96	0.981 39	16	1.061 68	0.941 90	27	1.105 67	0.904 43
6	1.022 80	0.977 71	17	1.065 63	0.938 41	28	1.119 72	0.901 13
7	1.026 63	0.974 06	18	1.069 59	0.934 94	29	1.113 82	0.897 84
8	1.030 48	0.970 42	19	1.073 56	0.931 48	30	1.117 82	0.894 57
9	1.034 35	0.966 79	20	1.077 42	0.928 14			
10	1.038 22	0.963 19	21	1.081 64	0.924 52			

TABLE OF TENSILE STRENGTH FOR COPPER WIRE.

Size of Wire, B. & S. Gauge.	Breaking Weight of Hard-Drawn.	Breaking Weight of Annealed.	Size of Wire, B. & S. Gauge.	Breaking Weight of Hard-Drawn.	Breaking Weight of Annealed.
	Lbs.	*Lbs.*		*Lbs.*	*Lbs.*
0000	9 971	5 650	9	617	349
000	7 907	4 480	10	489	277
00	6 271	3 553	11	388	219
0	4 973	2 818	12	307	174
1	3 943	2 234	13	244	138
2	3 127	1 772	14	193	109
3	2 480	1 405	15	153	87
4	1 967	1 114	16	133	69
5	1 559	883	17	97	55
6	1 237	700	18	77	43
7	980	555	19	61	34
8	778	440	20	48	27

FUSING EFFECTS OF ELECTRIC CURRENTS.

By W. H. PREECE, F.R.S.

[See "Proc. Roy. Soc.," Vol. XLIX., March 15, 1888.]

The Law—$C = ad^{\frac{3}{2}}$, where, C current; a, constant; and d, diameter—is strictly followed; and the following are the final values of the constant, "a," for the different metals as determined by Mr. Preece:

	Inches.	Centimeters.	Millimeters.
Copper	10,244	2,530	80.0
Aluminum	7,585	1,873	59.2
Platinum	5,172	1,277	40.4
German Silver	5,230	1,292	40.8
Platinoid	4,750	1,173	37.1
Iron	3,148	777.4	24.6
Tin	1,642	405.5	12.8
Alloy (Lead and Tin 2 to 1)	1,318	325.5	10.3
Lead	1,379	340.6	10.8

With these constants the following tables have been calculated:

TABLE SHOWING THE AMPERES REQUIRED TO FUSE WIRES OF VARIOUS SIZES AND MATERIALS.

Number, S. W. G.	Diameter d.	$d^{\frac{3}{2}}$	Copper a=10,244.	Aluminum a=7585.	Platinum a=5172.	German Silver a=5230.	Platinoid a=4750.	Iron a=3148.	Tin a=1642.	Tin-lead Alloy a=1318.	Lead a=1379.
14	0.080 0	0.022 627	231.80	171.600	117.000	118.300	107.500	71.220	37.150	29.820	31.200
16	0.064 0	0.016 191	165.80	122.800	83.730	84.680	76.900	50.960	26.580	21.340	22.320
18	0.048 0	0.010 516	107.70	79.750	54.370	54.990	49 950	33.100	17.270	13.860	14.500
20	0.036 0	0.006 831	69.97	51.180	35.330	35.720	32.440	21.500	11.220	9.002	9.419
22	0.028 0	0.004 685	48.00	35.530	24.230	24.500	22.250	14.750	7.692	6.175	6.461
24	0.022 0	0.003 263	33.43	24.750	16.880	17.060	15.500	10.270	5.357	4.300	4.499
26	0.018 0	0.002 415	24.74	18.320	12.490	12.630	11.470	7.602	3.965	3.183	3.330
28	0.014 8	0.001 801	18.44	13.660	9.311	9.416	8.552	5.667	2.956	2.373	2.483
30	0.012 4	0.001 381	14.15	10.470	7.142	7.222	6.559	4.347	2.267	1.820	1.904
32	0.010 8	0.001 122	11.50	8.512	5.805	5.870	5.330	3.533	1.843	1.479	1.548

NOTE.—The size of "cut-outs," or fuses for electric-lighting circuits, can be taken at once from the second table. Pure copper wire makes the best and most reliable cut-out or fuse, and should never be less than one inch in length between the terminals to which it is fixed so as to prevent the cooling effect of the terminals.

TABLE GIVING THE DIAMETER OF WIRES OF VARIOUS MATERIALS WHICH WILL BE FUSED BY A CURRENT OF GIVEN STRENGTH.

W. H. Preece, F.R.S.

$$d = \left(\frac{C}{a}\right)^{\frac{2}{3}}$$

Current in Amperes.	Diameter in Inches.								
	Copper a=10,244.	Aluminum a=7585.	Platinum a=5172.	German Silver a=5230.	Platinoid a=4750.	Iron a=3148.	Tin a=1642.	Tin-lead Alloy a=1318.	Lead a=1379.
1	0.002 1	0.002 6	0.003 3	0.003 3	0.003 5	0.004 7	0.007 2	0.008 3	0.008 1
2	0.003 4	0.004 1	0.005 3	0.005 3	0.005 6	0.007 4	0.011 3	0.013 2	0.012 8
3	0.004 4	0.005 4	0.007 0	0.006 9	0.007 4	0.009 7	0.014 9	0.017 3	0.016 8
4	0.005 3	0.006 5	0.008 4	0.008 4	0.008 9	0.011 7	0.018 1	0.021 0	0.020 3
5	0.006 2	0.007 6	0.009 8	0.009 7	0.010 4	0.013 6	0.021 0	0.024 3	0.023 6
10	0.009 8	0.012 0	0.015 5	0.015 4	0.016 4	0.021 6	0.033 4	0.038 6	0.037 5
15	0.012 9	0.015 8	0.020 3	0.020 2	0.021 5	0.028 3	0.043 7	0.050 6	0.049 1
20	0.015 6	0.019 1	0.024 6	0.024 5	0.026 1	0.034 3	0.052 9	0.061 3	0.059 5
25	0.018 1	0.022 2	0.028 6	0.028 4	0.030 3	0.039 8	0.061 4	0.071 1	0.069 0
30	0.020 5	0.025 0	0.032 3	0.032 0	0.034 2	0.045 0	0.069 4	0.080 3	0.077 9
35	0.022 7	0.027 7	0.035 8	0.035 6	0.037 9	0.049 8	0.076 9	0.089 0	0.086 4
40	0.024 8	0.030 3	0.039 1	0.038 8	0.041 4	0.054 5	0.084 0	0.097 3	0.094 4
45	0.026 8	0.032 8	0.042 3	0.042 0	0.044 8	0.058 9	0.090 9	0.105 2	0.102 1
50	0.028 8	0.035 2	0.045 4	0.045 0	0.048 0	0.063 2	0.097 5	0.112 9	0.109 5
60	0.032 5	0.039 7	0.051 3	0.050 9	0.054 2	0.071 4	0.110 1	0.127 5	0.123 7
70	0.036 0	0.044 0	0.056 8	0.056 4	0.060 1	0.079 1	0.122 0	0.141 3	0.137 1
80	0.039 4	0.048 1	0.062 1	0.061 6	0.065 7	0.086 4	0.133 4	0.154 4	0.149 9
90	0.042 6	0.052 0	0.067 2	0.066 7	0.071 1	0.093 5	0.144 3	0.167 1	0.162 1
100	0.045 7	0.055 8	0.072 0	0.071 5	0.076 2	0.100 3	0.154 8	0.179 2	0.173 9
120	0.051 6	0.063 0	0.081 4	0.080 8	0.086 1	0.113 3	0.174 8	0.202 4	0.196 4
140	0.057 2	0.069 8	0.090 2	0.089 5	0.095 4	0.125 5	0.193 7	0.224 3	0.217 6
160	0.062 5	0.076 3	0.098 6	0.097 8	0.104 3	0.137 2	0.211 8	0.245 2	0.237 9
180	0.067 6	0.082 6	0.106 6	0.105 8	0.112 8	0.148 4	0.229 1	0.265 2	0.257 3
200	0.072 5	0.088 6	0.114 4	0.113 5	0.121 0	0.159 2	0.245 7	0.284 5	0.276 0
225	0.078 4	0.095 8	0.123 7	0.122 8	0.130 9	0.172 2	0.265 8	0.307 7	0.298 6
250	0.084 1	0.102 8	0.132 7	0.131 7	0.140 4	0.184 8	0.285 1	0.330 1	0.320 3
275	0.089 7	0.109 5	0.141 4	0.140 4	0.149 7	0.196 9	0.303 8	0.351 8	0.341 3
300	0.095 0	0.116 1	0.149 8	0.148 7	0.158 6	0.208 6	0.322 0	0.372 8	0.361 7

WIRING TABLES.

Calculated by F. A. C. PERRINE, D.Sc.

The first section of these tables is calculated from the expression of Ohm's law $R = \frac{E}{C}$, and gives the resistances for currents from one to one hundred amperes at voltages varying by half volts from one-half to ten volts, and the resistances for currents from one to two hundred amperes at voltages varying by single volts from ten to twenty volts. The second section furnishes the actual resistance of copper wire drawn according to the Brown & Sharpe gauge for various distances at 70° F.

From the first section we can get the required resistance of any circuit absorbing an electromotive force with a given current, and from the second the wire which will be of the required resistance.

Rule.—The first column of the tables of loss of voltage on any circuit represents, with the uppermost cross-row of figures, amperes. The figures in the other columns represent resistances of circuits carrying different currents at the loss of voltage given by the table. Thus:

What must be the resistance of a circuit carrying 98 amperes to show a drop of 3.5 volts? *Ans.* .0357 ohms.

Now, to obtain the requisite size of wire necessary to carry 98 amperes 550 feet (that is, for a distance of 225 feet—the total length of circuit then being 550 feet), it is necessary to look in the tables showing resistances of the various sizes of wires at different lengths, and obtain a wire whose resistance at 550 feet equals .0357 ohms. Doing this, we find that the resistance of a No. 000 B. & S. wire, 550 feet in length, would be .03454 ohms. Therefore, we would select a No. 000 B. & S. copper wire to carry 98 amperes 550 feet, with a drop (or loss) of 3.5 volts.

Example.—Required, the size wire to carry 87 amperes 1,850 feet, on a 110 volt circuit, the drop being 5 per cent.

Ans. The absolute loss of voltage on this circuit is 5.5 volts. The resistance of a circuit carrying 87 amperes with 5.5 volts loss, from the tables, is found to be .0632 ohms. Upon inspec-

tion of the tables, giving the resistance of wire, it is found that none show so low a resistance as .0632 ohms for 1850 feet. If now we multiply the required resistance by 2, we may find a wire which would carry ½ the current under the conditions named; thus: $.0632 \times 2 = .1264$ ohms. Now, upon inspection of the tables, we can find no wire 1850 feet in length showing .1264 ohms resistance, and so we try with the multiple 3 to divide the line into 3 circuits each carrying ⅓ of the current; thus: .0632 ohms $\times\ 3 = .1896$ ohms. The nearest approach to this resistance for 1850 feet is a No. 0 wire. Therefore three No. 0 B. & S. wires or their equivalent would carry 87 amperes 1850 feet, with a loss of 5.5 volts.

TABLES SHOWING RESISTANCE OF ANY CIRCUIT CARRYING A GIVEN NUMBER OF AMPERES WITH A GIVEN LOSS OF ELECTROMOTIVE FORCE.

AT .5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	.500 0	.250 0	.166 7	.125 0	.100 0	.083 3	.071 4	.062 5	.055 6
10	.050 0	.045 4	.041 7	.038 5	.035 7	.033 3	.031 2	.029 4	.027 8	.026 3
20	.025 0	.023 8	.022 7	.021 7	.020 8	.020 0	.019 2	.018 5	.017 8	.017 2
30	.016 7	.016 1	.015 6	.015 1	.014 7	.014 3	.013 9	.013 5	.013 2	.012 8
40	.012 5	.012 2	.011 9	.011 6	.011 4	.011 1	.010 9	.010 6	.010 4	.010 2
50	.010 0	.009 8	.009 6	.009 4	.009 2	.009 1	.008 9	.008 8	.008 6	.008 5
60	.008 3	.008 2	.008 1	.007 9	.007 8	.007 7	.007 6	.007 5	.007 3	.007 2
70	.007 1	.007 0	.006 9	.006 8	.006 7	.006 7	.006 6	.006 5	.006 4	.006 3
80	.006 2	.006 2	.006 1	.006 0	.005 9	.005 9	.005 8	.005 7	.005 7	.005 6
90	.005 5	.005 5	.005 4	.005 4	.005 3	.005 3	.005 2	.005 1	.005 1	.005 0

AT 1 VOLT LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	1.000 0	.500 0	.333 3	.250 0	.200 0	.166 7	.142 9	.125 0	.111 1
10	.100 0	.090 9	.083 3	.076 9	.071 4	.066 7	.062 5	.058 8	.055 6	.052 6
20	.050 0	.047 6	.045 5	.043 5	.041 7	.040 0	.038 5	.037 0	.035 7	.034 5
30	.033 3	.032 3	.031 3	.030 3	.029 4	.028 6	.027 8	.027 0	.026 3	.025 6
40	.025 0	.024 4	.023 8	.023 3	.022 7	.022 2	.021 7	.021 3	.020 8	.020 4
50	.020 0	.019 6	.019 2	.018 9	.018 5	.018 2	.017 9	.017 5	.017 2	.016 9
60	.016 7	.016 4	.016 1	.015 9	.015 6	.015 4	.015 2	.014 9	.014 7	.014 5
70	.014 3	.014 1	.013 9	.013 7	.013 5	.013 3	.013 2	.013 0	.012 8	.012 7
80	.012 5	.012 3	.012 2	.012 0	.011 9	.011 8	.011 6	.011 5	.011 4	.011 2
90	.011 1	.011 0	.010 9	.010 8	.010 6	.010 5	.010 4	.010 3	.010 2	.010 1
100	.010 0	.009 9	.009 8	.009 7	.009 6	.009 5	.009 4	.009 3	.009 3	.009 2

AT 1.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	1.500 0	.750 0	.500 0	.375 0	.300 0	.250 0	.214 3	.187 5	.166 7
10	.150 0	.136 4	.125 0	.115 4	.107 1	.100 0	.093 7	.088 2	.083 3	.078 9
20	.075 0	.071 4	.068 2	.065 2	.062 5	.060 0	.057 7	.055 5	.053 6	.051 7
30	.050 0	.048 4	.046 9	.045 4	.044 1	.042 9	.041 7	.040 5	.039 5	.038 5
40	.037 5	.036 6	.035 7	.034 9	.034 1	.033 3	.032 6	.031 9	.031 2	.030 6
50	.030 0	.029 4	.028 8	.028 3	.027 8	.027 3	.026 8	.026 3	.025 9	.025 4
60	.025 0	.024 6	.024 2	.023 8	.023 4	.023 1	.022 7	.022 4	.022 1	.021 7
70	.021 4	.021 1	.020 8	.020 5	.020 3	.020 0	.019 7	.019 5	.019 2	.019 0
80	.018 7	.018 5	.018 3	.018 1	.017 8	.017 6	.017 4	.017 2	.017 0	.016 9
90	.016 7	.016 5	.016 3	.016 1	.016 0	.015 8	.015 6	.015 5	.015 3	.015 1

AT 2 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	2.000 0	1.000 0	.666 7	.500 0	.400 0	.333 3	.285 7	.250 0	.222 2
10	.200 0	.181 8	.166 7	.153 8	.142 9	.133 3	.125 0	.117 6	.111 1	.105 3
20	.100 0	.095 2	.090 9	.087 0	.083 3	.080 0	.076 9	.074 1	.071 4	.069 0
30	.066 7	.064 5	.062 5	.060 6	.058 8	.057 1	.055 5	.054 0	.052 6	.051 3
40	.050 0	.048 8	.047 6	.046 5	.045 5	.044 4	.043 5	.042 6	.041 7	.040 8
50	.040 0	.039 2	.038 5	.037 7	.037 0	.036 4	.035 7	.035 1	.034 5	.033 9
60	.033 3	.032 8	.032 3	.031 7	.031 2	.030 8	.030 3	.029 8	.029 4	.029 0
70	.028 6	.028 2	.027 8	.027 4	.027 0	.026 7	.026 3	.026 0	.025 6	.025 3
80	.025 0	.024 7	.024 4	.024 1	.023 8	.023 5	.023 3	.023 0	.022 7	.022 5
90	.022 2	.022 0	.021 7	.021 5	.021 3	.021 0	.020 8	.020 6	.020 4	.020 2

AT 2.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	2.500 0	1.250 0	.833 3	.625 0	.500 0	.416 6	.357 1	.312 5	.277 8
10	.250 0	.227 2	.208 3	.192 3	.178 6	.166 7	.156 2	.147 0	.138 9	.131 6
20	.125 0	.119 0	.113 6	.108 7	.104 2	.100 0	.096 1	.092 6	.089 2	.086 2
30	.083 3	.080 6	.078 1	.075 7	.073 5	.071 4	.069 4	.067 6	.065 8	.064 1
40	.062 5	.060 9	.059 5	.058 1	.056 8	.055 5	.054 3	.053 2	.052 1	.051 0
50	.050 0	.049 0	.048 1	.047 2	.046 3	.045 4	.044 6	.043 8	.043 1	.042 4
60	.041 7	.041 0	.040 3	.039 7	.039 1	.038 4	.037 9	.037 3	.036 8	.036 2
70	.035 7	.035 2	.034 7	.034 2	.033 8	.033 3	.032 9	.032 5	.032 0	.031 6
80	.031 2	.030 9	.030 5	.030 1	.029 7	.029 4	.029 1	.028 7	.028 4	.028 1
90	.027 8	.027 5	.027 2	.026 9	.026 6	.026 3	.026 0	.025 8	.025 5	.025 2

AT 3 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	3.000 0	1.500 0	1.000 0	.750 0	.600 0	.500 0	.428 6	.375 0	.333 3
10	.300 0	.272 7	.250 0	.230 8	.214 3	.200 0	.187 5	.176 5	.166 7	.157 9
20	.150 0	.142 9	.136 4	.130 4	.125 0	.120 0	.115 4	.111 1	.107 1	.103 4
30	.100 0	.096 8	.093 7	.090 9	.088 2	.085 7	.083 3	.081 1	.078 9	.076 9
40	.075.0	.073 2	.071 4	.069 8	.068 2	.066 7	.065 2	.063 8	.062 5	.061 2
50	.060 0	.058 8	.057 7	.056 6	.055 6	.054 6	.053 6	.052 6	.051 7	.050 8
60	.050 0	.049 2	.048 4	.047 6	.046 9	.046 2	.045 5	.044 8	.044 1	.043 5
70	.042 9	.042 3	.041 7	.041 1	.040 5	.040 0	.039 5	.039 0	.038 5	.038 0
80	.037 5	.037 0	.036 6	.036 2	.035 7	.035 3	.034 9	.034 5	.034 1	.033 7
90	.033 3	.033 0	.032 6	.032 3	.031 9	.031 6	.031 2	.030 9	.030 6	.030 3

AT 3.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	3.500 0	1.750 0	1.166 7	.875 0	.700 0	.583 3	.500 0	.437 5	.388 9
10	.350 0	.318 2	.291 7	.269 2	.250 0	.233 3	.218 8	.205 9	.194 4	.184 2
20	.175 0	.166 7	.159 1	.152 2	.145 8	.140 0	.134 6	.129 6	.125 0	.120 7
30	.116 7	.112 9	.109 4	.106 0	.102 9	.100 0	.097 2	.094 6	.092 1	.089 7
40	.087 5	.085 4	.083 3	.081 4	.079 5	.077 8	.076 1	.074 5	.072 9	.071 4
50	.070 0	.068 6	.067 3	.066 0	.064 8	.063 6	.062 5	.061 4	.060 3	.059 3
60	.058 3	.057 4	.056 5	.055 6	.054 7	.053 8	.053 0	.052 2	.051 5	.050 7
70	.050 0	.049 3	.048 6	.047 9	.047 3	.046 7	.046 0	.045 5	.044 9	.044 3
80	.043 7	.043 2	.042 7	.042 2	.041 7	.041 2	.040 7	.040 2	.039 8	.039 3
90	.038 9	.038 5	.038 0	.037 6	.037 2	.036 8	.036 5	.036 1	.035 7	.035 4

AT 4 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	4.000 0	2.000 0	1.333 3	1.000 0	.800 0	.666 7	.571 4	.500 0	.444 4
10	.400 0	.363 6	.333 3	.307 7	.285 7	.266 7	.250 0	.235 3	.222 2	.210 5
20	.200 0	.190 5	.181 8	.173 9	.166 7	.160 0	.153 8	.148 2	.142 8	.137 9
30	.133 3	.129 0	.125 0	.121 2	.117 6	.114 3	.111 1	.108 1	.105 3	.102 6
40	.100 0	.097 6	.095 2	.093 0	.090 9	.088 9	.087 0	.085 1	.083 3	.081 6
50	.080 0	.078 4	.076 9	.075 5	.074 1	.072 7	.071 4	.070 2	.069 0	.067 8
60	.066 7	.065 6	.064 5	.063 5	.062 5	.061 5	.060 6	.059 7	.058 8	.058 0
70	.057 1	.056 3	.055 6	.054 8	.054 1	.053 3	.052 6	.051 9	.051 3	.050 6
80	.050 0	.049 4	.048 8	.048 2	.047 6	.047 1	.046 5	.046 0	.045 5	.044 9
90	.044 4	.044 0	.043 5	.043 0	.042 6	.042 1	.041 7	.041 2	.040 8	.040 4

AT 4.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	4.500 0	2.250 0	1.500 0	1.125 0	.900 0	.750 0	.642 8	.562 5	.500 0
10	.450 0	.409 1	.375 0	.346 1	.321 4	.300 0	.281 2	.264 7	.250 0	.236 8
20	.225 0	.214 3	.204 5	.195 7	.187 5	.180 0	.173 1	.166 7	.160 7	.155 2
30	.150 0	.145 2	.140 6	.136 4	.132 3	.128 5	.125 0	.121 6	.118 4	.115 4
40	.112 5	.109 7	.107 1	.104 7	.102 3	.100 0	.097 8	.095 7	.093 7	.091 8
50	.090 0	.088 2	.086 5	.084 9	.083 3	.081 8	.080 4	.078 9	.077 6	.076 3
60	.075 0	.073 8	.072 6	.071 4	.070 3	.069 2	.068 2	.067 2	.066 2	.065 2
70	.064 3	.063 4	.062 5	.061 6	.060 8	.060 0	.059 2	.058 4	.057 7	.056 9
80	.056 2	.055 6	.054 9	.054 2	.053 5	.052 9	.052 3	.051 7	.051 1	.050 6
90	.050 0	.049 4	.048 9	.048 4	.047 9	.047 4	.046 9	.046 4	.045 9	.045 5

AT 5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	5.000 0	2.500 0	1.666 7	1.250 0	1.000 0	.833 3	.714 3	.625 0	.555 5
10	.500 0	.454 5	.416 7	.384 6	.357 1	.333 3	.312 5	.294 1	.277 8	.263 2
20	.250 0	.238 1	.227 2	.217 4	.208 3	.200 0	.192 3	.185 2	.178 6	.172 4
30	.166 7	.161 3	.156 2	.151 5	.147 0	.142 9	.138 9	.135 1	.131 6	.128 2
40	.125 0	.122 0	.119 0	.116 3	.113 6	.111 1	.108 7	.106 4	.104 2	.102 0
50	.100 0	.098 0	.096 1	.094 4	.092 6	.090 9	.089 3	.087 7	.086 2	.084 8
60	.083 3	.082 0	.080 6	.079 4	.078 1	.076 9	.075 8	.074 6	.073 5	.072 5
70	.071 4	.070 4	.069 4	.068 5	.067 6	.066 7	.065 8	.064 9	.064 1	.063 3
80	.062 5	.061 7	.061 0	.060 2	.059 5	.058 8	.058 1	.057 5	.056 8	.056 2
90	.055 6	.055 0	.054 3	.053 7	.053 2	.052 6	.052 1	.051 5	.051 0	.050 5

AT 5.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	5.500 0	2.750 0	1.833 3	1.375 0	1.100 0	.916 7	.785 7	.687 5	.611 1
10	.550 0	.500 0	.458 3	.423 0	.392 9	.366 7	.343 7	.323 5	.305 6	.289 5
20	.275 0	.261 9	.250 0	.239 1	.229 2	.220 0	.211 5	.203 7	.196 4	.189 7
30	.183 3	.177 4	.171 9	.166 7	.161 8	.157 1	.152 8	.148 6	.144 7	.141 0
40	.137 5	.134 1	.130 9	.127 9	.125 0	.122 2	.119 6	.117 0	.114 6	.112 2
50	.110 0	.107 8	.105 8	.103 8	.101 9	.100 0	.098 2	.096 5	.094 8	.093 2
60	.091 7	.090 2	.088 7	.087 3	.085 9	.084 6	.083 3	.082 1	.080 9	.079 7
70	.078 5	.077 5	.076 4	.075 3	.074 3	.073 3	.072 4	.071 4	.070 5	.069 6
80	.068 7	.067 9	.067 1	.066 3	.065 5	.064 7	.064 0	.063 2	.062 5	.061 8
90	.061 1	.060 4	.059 8	.059 1	.058 5	.057 9	.057 3	.056 7	.056 1	.055 6

AT 6 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	6.000 0	3.000 0	2.000 0	1.500 0	1.200 0	1.000 0	.857 1	.750 0	.666 7
10	.600 0	.545 5	.500 0	.461 5	.428 6	.400 0	.375 0	.352 9	.333 3	.315 8
20	.300 0	.285 7	.272 7	.260 9	.250 0	.240 0	.230 8	.222 2	.214 3	.206 9
30	.200 0	.193 6	.187 5	.181 8	.176 5	.171 4	.166 7	.162 2	.157 9	.153 8
40	.150 0	.146 3	.142 9	.139 5	.136 4	.133 3	.130 5	.127 7	.125 0	.122 4
50	.120 0	.117 7	.115 4	.113 2	.111 1	.109 1	.107 1	.105 3	.103 5	.101 7
60	.100 0	.098 4	.096 8	.095 2	.093 8	.092 3	.090 9	.089 6	.088 2	.087 0
70	.085 7	.084 5	.083 3	.082 2	.081 1	.080 0	.079 0	.078 0	.076 9	.076 0
80	.075 0	.074 1	.073 2	.072 3	.071 4	.070 6	.069 8	.069 0	.068 2	.067 4
90	.066 7	.066 0	.065 2	.064 5	.063 8	.063 2	.062 5	.061 9	.061 2	.060 6

AT 6.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	6.500 0	3.250 0	2.166 7	1.625 0	1.300 0	1.083 3	.928 5	.812 5	.722 2
10	.650 0	.590 9	.541 7	.500 0	.464 3	.433 3	.406 3	.382 4	.361 1	.342 1
20	.325 0	.309 5	.295 5	.282 6	.270 8	.260 0	.250 0	.240 7	.232 1	.224 1
30	.216 7	.209 7	.203 1	.197 0	.191 2	.185 7	.180 6	.175 7	.171 0	.166 7
40	.162 5	.158 5	.154 8	.151 2	.147 7	.144 4	.141 3	.138 3	.135 4	.132 7
50	.130 0	.127 5	.125 0	.122 6	.120 4	.118 2	.116 1	.114 0	.112 0	.110 2
60	.108 3	.106 6	.104 8	.103 2	.101 6	.100 0	.098 5	.097 0	.095 7	.094 2
70	.092 9	.091 5	.090 3	.089 0	.087 8	.086 7	.085 5	.084 4	.083 3	.082 3
80	.081 3	.080 2	.079 3	.078 3	.077 4	.076 5	.075 6	.074 7	.073 9	.073 0
90	.072 2	.071 4	.070 6	.069 9	.069 1	.068 4	.067 7	.067 0	.066 3	.065 7

AT 7 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	7.000 0	3.500 0	2.333 3	1.750 0	1.400 0	1.166 7	1.000 0	.875 0	.777 8
10	.700 0	.636 4	.583 3	.538 5	.500 0	.466 7	.437 5	.411 8	.388 9	.368 4
20	.350 0	.333 3	.318 2	.304 5	.291 7	.280 0	.269 2	.259 3	.250 0	.241 4
30	.233 3	.225 8	.218 8	.212 1	.205 9	.200 0	.194 4	.189 2	.184 2	.179 5
40	.175 0	.170 7	.166 7	.162 8	.159 1	.155 6	.152 2	.149 0	.145 8	.142 9
50	.140 0	.137 3	.134 6	.132 1	.129 6	.127 3	.125 0	.122 8	.120 7	.118 6
60	.116 7	.114 8	.112 9	.111 1	.109 4	.107 7	.106 1	.104 5	.103 0	.101 4
70	.100 0	.098 6	.097 2	.095 9	.094 6	.093 3	.092 1	.090 9	.089 7	.088 6
80	.087 5	.086 4	.085 4	.084 4	.083 3	.082 4	.081 4	.080 5	.079 5	.078 7
90	.077 8	.076 9	.076 1	.075 3	.074 5	.073 7	.072 9	.072 2	.071 4	.070 7

AT 7.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	7.500 0	3.750 0	2.500 0	1.875 0	1.500 0	1.250 0	1.071 4	.937 5	.833 3
10	.750 0	.681 8	.625 0	.576 9	.535 7	.500 0	.468 7	.441 2	.416 7	.394 7
20	.375 0	.357 1	.340 9	.326 1	.312 5	.300 0	.288 5	.277 8	.267 9	.258 6
30	.250 0	.242 0	.234 4	.227 3	.220 6	.214 3	.208 3	.202 7	.197 4	.192 3
40	.187 5	.182 9	.178 6	.174 4	.170 5	.166 7	.163 0	.159 6	.156 2	.153 0
50	.150 0	.147 1	.144 2	.141 5	.138 9	.136 4	.133 9	.131 6	.129 3	.127 1
60	.125 0	.123 0	.121 0	.119 0	.117 2	.115 4	.113 6	.111 9	.110 3	.108 7
70	.107 1	.105 6	.104 2	.102 8	.101 4	.100 0	.098 7	.097 4	.096 2	.095 0
80	.093 7	.092 6	.091 5	.090 4	.089 3	.088 2	.087 2	.086 2	.085 2	.084 3
90	.083 3	.082 4	.081 5	.080 6	.079 8	.078 9	.078 1	.077 3	.076 5	.075 8

AT 8 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	8.000 0	4.000 0	2.666 7	2.000 0	1.600 0	1.333 3	1.142 9	1.000 0	.888 9
10	.800 0	.727 3	.666 7	.615 4	.571 4	.533 3	.500 0	.470 6	.444 4	.421 1
20	.400 0	.381 0	.363 6	.347 8	.333 3	.320 0	.307 7	.296 3	.285 7	.275 9
30	.266 7	.258 1	.250 0	.242 4	.235 3	.228 6	.222 2	.216 2	.210 6	.205 1
40	.200 0	.195 1	.190 5	.186 0	.181 8	.177 8	.173 9	.170 2	.166 7	.163 3
50	.160 0	.156 9	.153 8	.151 0	.148 2	.145 5	.142 9	.140 3	.137 9	.135 6
60	.133 3	.131 1	.129 0	.127 0	.125 0	.123 0	.121 2	.119 4	.117 7	.115 9
70	.114 3	.112 7	.111 1	.109 6	.108 1	.106 7	.105 3	.103 9	.102 6	.101 3
80	.100 0	.098 8	.097 6	.096 4	.095 2	.094 1	.093 0	.092 0	.090 9	.089 9
90	.088 9	.087 9	.087 0	.086 0	.085 1	.084 2	.083 3	.082 5	.081 6	.080 8

AT 8.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	8.500 0	4.250 0	2.833 3	2.125 0	1.700 0	1.416 7	1.214 3	1.062 5	.944 4
10	.850 0	.772 7	.708 3	.653 8	.607 1	.566 7	.531 2	.500 0	.472 2	.447 4
20	.425 0	.404 8	.386 4	.369 6	.354 2	.340 0	.326 9	.314 8	.303 6	.293 1
30	.283 3	.274 2	.265 6	.257 6	.250 0	.242 9	.236 1	.229 7	.223 7	.217 9
40	.212 5	.207 3	.202 4	.197 7	.193 2	.188 9	.184 8	.180 8	.177 1	.173 5
50	.170 0	.166 7	.163 5	.160 4	.157 4	.154 5	.151 8	.149 1	.146 6	.144 1
60	.141 7	.139 3	.137 1	.134 9	.132 8	.130 8	.128 8	.126 9	.125 0	.123 2
70	.121 4	.119 7	.118 1	.116 4	.114 9	.113 3	.111 8	.110 4	.109 0	.107 6
80	.106 2	.104 9	.103 7	.102 4	.101 2	.100 0	.098 8	.097 7	.096 6	.095 5
90	.094 4	.093 4	.092 4	.091 4	.090 4	.089 5	.088 5	.087 6	.086 7	.085 9

AT 9 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	9.000 0	4.500 0	3.000 0	2.250 0	1.800 0	1.500 0	1.285 7	1.125 0	1.000 0
10	.900 0	.818 2	.750 0	.692 3	.642 9	.600 0	.562 5	.529 4	.500 0	.473 7
20	.450 0	.428 6	.409 1	.391 3	.375 0	.360 0	.346 1	.333 3	.321 4	.310 3
30	.300 0	.290 3	.281 3	.272 7	.264 7	.257 1	.250 0	.243 2	.236 8	.230 8
40	.225 0	.219 5	.214 3	.209 3	.204 5	.200 0	.195 7	.191 5	.187 5	.183 7
50	.180 0	.176 6	.173 1	.169 8	.166 7	.163 7	.160 7	.157 9	.155 2	.152 5
60	.150 0	.147 5	.145 2	.142 9	.140 6	.138 5	.136 4	.134 3	.132 4	.130 4
70	.128 6	.126 8	.125 0	.123 4	.121 6	.120 0	.118 4	.116 9	.115 4	.113 9
80	.112 5	.111 1	.109 8	.108 4	.107 1	.105 9	.104 7	.103 3	.102 3	.101 1
90	.100 0	.098 9	.097 8	.096 8	.095 7	.094 7	.093 8	.092 8	.091 8	.090 9

AT 9.5 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	9.500 0	4.750 0	3.166 7	2.375 0	1.900 0	1.583 3	1.357 2	1.187 5	1.055 6
10	.950 0	.863 6	.791 7	.730 8	.678 6	.633 3	.593 7	.558 8	.527 8	.500 0
20	.475 0	.452 4	.431 8	.413 0	.395 8	.380 0	.365 4	.351 9	.339 3	.327 6
30	.316 7	.306 5	.296 9	.287 9	.279 4	.271 4	.263 9	.256 8	.250 0	.243 6
40	.237 5	.231 7	.226 2	.220 9	.215 9	.211 1	.206 5	.202 1	.197 9	.193 8
50	.190 0	.186 3	.182 7	.179 2	.175 9	.172 7	.169 6	.166 7	.163 8	.161 0
60	.158 3	.155 7	.153 2	.150 8	.148 4	.146 2	.143 9	.141 8	.139 7	.137 7
70	.135 7	.133 8	.132 0	.130 1	.128 4	.126 7	.125 0	.123 4	.121 6	.120 3
80	.118 7	.117 3	.115 9	.114 5	.113 1	.111 8	.110 5	.109 2	.108 0	.106 7
90	.105 6	.104 4	.103 3	.102 2	.101 1	.100 0	.098 9	.097 9	.096 9	.095 9

AT 10 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	10.000 0	5.000 0	3.333 3	2.500 0	2.000 0	1.666 7	1.428 6	1.250 0	1.111 1
10	1.000 0	.909 1	.833 3	.769 2	.714 3	.666 7	.625 0	.588 2	.555 6	.526 3
20	.500 0	.476 2	.454 5	.434 8	.416 7	.400 0	.384 6	.370 4	.357 1	.344 8
30	.333 3	.322 6	.312 5	.303 0	.294 1	.285 7	.277 8	.270 3	.263 2	.256 4
40	.250 0	.243 9	.238 1	.232 6	.227 3	.222 2	.217 4	.212 8	.208 3	.204 1
50	.200 0	.196 1	.192 3	.188 7	.185 2	.181 8	.178 6	.175 4	.172 4	.169 5
60	.166 7	.163 9	.161 3	.158 7	.156 3	.153 8	.151 5	.149 3	.147 1	.144 9
70	.142 9	.140 8	.138 9	.137 0	.135 1	.133 3	.131 6	.129 9	.128 2	.126 6
80	.125 0	.123 5	.122 0	.120 5	.119 0	.117 6	.116 3	.114 9	.113 6	.112 4
90	.111 1	.109 9	.108 7	.107 5	.106 4	.105 3	.104 2	.103 1	.102 0	.101 0
100	.100 0	.099 0	.098 0	.097 1	.096 2	.095 2	.094 3	.093 5	.092 6	.091 7
110	.090 9	.090 1	.089 3	.088 5	.087 7	.087 0	.086 2	.085 5	.084 7	.084 0
120	.083 3	.082 6	.082 0	.081 3	.080 6	.080 0	.079 4	.078 7	.078 1	.077 5
130	.076 9	.076 3	.075 8	.075 2	.074 6	.074 1	.073 5	.073 0	.072 5	.071 9
140	.071 4	.070 9	.070 4	.069 9	.069 4	.069 0	.068 5	.068 0	.067 6	.067 1
150	.066 7	.066 2	.065 8	.065 4	.064 9	.064 5	.064 1	.063 7	.063 3	.062 9
160	.062 5	.062 1	.061 7	.061 3	.061 0	.060 6	.060 2	.059 9	.059 5	.059 2
170	.058 8	.058 5	.058 1	.057 8	.057 5	.057 1	.056 8	.056 5	.056 2	.055 9
180	.055 6	.055 2	.054 9	.054 6	.054 3	.054 1	.053 8	.053 5	.053 2	.052 9
190	.052 6	.052 4	.052 1	.051 8	.051 5	.051 3	.051 0	.050 8	.050 5	.050 3

AT 11 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	11.000 0	5.500 0	3.666 7	2.750 0	2.200 0	1.833 3	1.571 5	1.375 0	1.222 2
10	1.100 0	1.000 0	.916 7	.846 1	.785 7	.733 4	.687 5	.647 0	.611 1	.578 9
20	.550 0	.523 8	.500 0	.478 3	.458 3	.440 0	.423 1	.407 4	.392 9	.379 3
30	.366 7	.354 9	.343 8	.333 3	.323 5	.314 3	.305 6	.297 3	.289 5	.282 0
40	.275 0	.268 3	.261 9	.255 8	.250 0	.244 4	.239 1	.234 0	.229 2	.224 5
50	.220 0	.215 7	.211 5	.207 6	.203 7	.200 0	.196 4	.193 0	.189 7	.186 4
60	.183 4	.180 3	.177 4	.174 6	.171 9	.169 2	.166 7	.164 2	.161 8	.159 4
70	.157 2	.155 0	.152 8	.150 7	.148 6	.146 7	.144 7	.142 9	.141 0	.139 2
80	.137 5	.135 8	.134 1	.132 5	.131 0	.129 4	.127 9	.126 4	.125 0	.123 6
90	.122 2	.120 9	.119 6	.118 3	.117 0	.115 8	.114 6	.113 4	.112 2	.111 1
100	.110 0	.108 9	.107 8	.106 8	.105 8	.104 8	.103 8	.102 8	.101 9	.100 9
110	.100 0	.099 1	.098 2	.097 5	.096 5	.095 7	.094 8	.094 0	.093 2	.092 4
120	.091 6	.090 9	.090 2	.089 3	.088 7	.088 0	.087 3	.086 6	.085 9	.085 3
130	.084 6	.084 0	.083 3	.082 7	.082 1	.081 5	.080 9	.080 3	.079 7	.079 1
140	.078 5	.078 0	.077 4	.076 9	.076 4	.075 9	.075 4	.074 8	.074 3	.073 8
150	.073 4	.072 8	.072 3	.071 9	.071 4	.071 0	.070 5	.070 1	.069 6	.069 2
160	.068 8	.068 3	.067 9	.067 5	.067 1	.066 7	.066 2	.065 9	.065 5	.065 1
170	.064 7	.064 3	.063 9	.063 6	.063 2	.062 9	.062 5	.062 1	.061 8	.061 5
180	.061 2	.060 8	.060 4	.060 1	.059 8	.059 5	.059 1	.058 9	.058 5	.058 2
190	.057 9	.057 6	.057 3	.057 0	.056 6	.056 4	.056 1	.055 8	.055 6	.055 3

AT 12 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	12.000 0	6.000 0	4.000 0	3.000 0	2.400 0	2.000 0	1.714 4	1.500 0	1.333 3
10	1.200 0	1.090 9	1.000 0	.923 0	.857 1	.800 0	.750 0	.705 8	.666 7	.631 5
20	.600 0	.571 4	.545 5	.521 7	.500 0	.480 0	.451 6	.444 4	.428 5	.413 8
30	.400 0	.387 1	.375 0	.363 6	.352 9	.342 9	.333 4	.324 3	.315 8	.307 7
40	.300 0	.292 7	.285 7	.279 1	.272 7	.266 6	.260 8	.255 3	.249 9	.250 0
50	.240 0	.235 3	.230 7	.226 4	.222 2	.218 2	.214 3	.210 4	.206 8	.203 4
60	.200 0	.196 7	.193 5	.190 5	.187 5	.184 6	.181 9	.179 1	.176 5	.173 9
70	.171 5	.169 0	.166 7	.164 4	.162 1	.160 0	.157 9	.155 9	.153 8	.151 9
80	.150 0	.148 2	.146 4	.144 6	.142 8	.141 2	.139 5	.137 9	.136 4	.134 8
90	.133 3	.131 9	.130 5	.129 1	.127 6	.126 3	.125 0	.123 7	.122 4	.121 2
100	.120 0	.118 8	.117 6	.116 5	.115 4	.114 3	.113 2	.112 2	.111 2	.110 1
110	.109 1	.108 1	.107 1	.106 2	.105 3	.104 4	.103 4	.102 7	.101 7	.100 8
120	.100 0	.099 2	.098 4	.097 5	.096 8	.096 0	.095 2	.094 5	.093 7	.093 0
130	.092 3	.091 6	.091 0	.090 2	.089 6	.088 9	.088 4	.087 6	.087 0	.086 3
140	.085 7	.085 1	.084 5	.083 9	.083 3	.082 8	.082 2	.081 6	.081 1	.080 5
150	.080 0	.079 4	.078 9	.078 4	.077 9	.077 5	.076 9	.076 4	.075 9	.075 5
160	.075 0	.074 4	.074 1	.073 6	.073 2	.072 7	.072 3	.071 9	.072 5	.071 0
170	.070 6	.070 2	.069 7	.069 4	.069 0	.068 5	.068 2	.067 9	.067 4	.067 1
180	.066 7	.066 2	.065 9	.065 6	.065 1	.064 9	.064 5	.064 2	.063 8	.063 5
190	.063 2	.062 8	.062 5	.062 2	.061 8	.061 5	.061 2	.061 0	.060 7	.060 2

AT 13 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	13.000 0	6.500 0	4.333 2	3.250 0	2.600 0	2.166 7	1.857 1	1.625 0	1.444 4
10	1.300 0	1.181 8	1.083 3	1.000 0	.928 6	.866 7	.812 5	.764 7	.722 2	.684 2
20	.650 0	.619 0	.590 9	.565 2	.541 7	.520 0	.500 0	.481 5	.464 3	.448 3
30	.433 2	.419 4	.406 3	.393 9	.382 2	.371 4	.361 1	.351 4	.342 1	.333 3
40	.325 0	.317 1	.309 5	.302 2	.295 5	.288 9	.282 6	.276 6	.270 8	.265 3
50	.260 0	.254 9	.250 0	.245 3	.240 7	.236 4	.232 1	.228 1	.224 1	.220 3
60	.216 7	.213 1	.209 7	.206 4	.203 1	.200 0	.197 0	.194 0	.191 2	.188 4
70	.185 7	.183 1	.180 6	.178 1	.175 7	.173 3	.171 1	.168 8	.166 7	.164 6
80	.162 5	.160 5	.158 5	.156 6	.154 8	.152 9	.151 2	.149 4	.147 7	.146 1
90	.144 4	.142 9	.141 3	.139 8	.138 3	.136 8	.135 4	.134 0	.132 7	.131 3
100	.130 0	.128 7	.127 4	.126 2	.125 0	.123 8	.122 6	.121 5	.120 4	.119 3
110	.118 2	.117 1	.116 1	.115 0	.114 0	.113 0	.112 1	.111 1	.110 2	.109 2
120	.108 3	.107 4	.106 6	.105 7	.104 8	.104 0	.103 2	.102 4	.101 6	.100 8
130	.100 0	.099 2	.098 5	.097 7	.097 0	.096 3	.095 6	.094 9	.094 2	.093 5
140	.092 9	.092 2	.091 5	.090 9	.090 3	.089 7	.089 0	.088 4	.087 8	.087 2
150	.086 7	.086 1	.085 5	.085 0	.084 4	.083 9	.083 3	.082 8	.082 3	.081 8
160	.081 3	.080 7	.080 2	.079 8	.079 3	.078 8	.078 3	.077 8	.077 4	.076 9
170	.076 5	.076 0	.075 6	.075 1	.074 7	.074 3	.073 9	.073 4	.073 0	.072 6
180	.072 2	.071 8	.071 4	.071 0	.070 7	.070 3	.069 9	.069 5	.069 1	.068 9
190	.068 4	.068 1	.067 8	.067 4	.067 0	.066 6	.066 3	.066 0	.065 7	.065 3

AT 14 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	14.000 0	7.000 0	4.666 7	3.500 0	2.800 0	2.333 3	2.000 0	1.750 0	1.555 5
10	1.400 0	1.272 7	1.166 7	1.076 8	1.000 0	.933 3	.875 0	.823 5	.777 8	.736 8
20	.700 0	.666 7	.636 3	.608 7	.583 3	.560 0	.538 4	.518 6	.500 0	.482 7
30	.466 6	.451 6	.437 5	.424 2	.411 7	.400 0	.388 9	.378 4	.368 5	.359 0
40	.350 0	.341 5	.333 3	.325 6	.318 2	.311 0	.304 4	.297 9	.291 6	.285 7
50	.280 0	.274 5	.269 2	.264 2	.259 3	.254 5	.250 0	.245 6	.241 4	.237 3
60	.233 3	.229 5	.225 8	.222 2	.218 8	.215 4	.212 1	.209 0	.205 9	.202 9
70	.200 0	.197 2	.194 5	.191 8	.189 1	.186 7	.184 2	.181 8	.179 5	.177 2
80	.175 0	.172 8	.170 7	.168 7	.166 7	.164 7	.162 8	.160 9	.159 1	.157 3
90	.155 5	.153 8	.152 2	.150 6	.149 0	.147 4	.145 8	.144 3	.142 9	.141 4
100	.140 0	.138 6	.137 2	.135 9	.134 5	.133 3	.132 1	.130 8	.129 6	.128 4
110	.127 3	.126 1	.125 0	.123 9	.122 8	.121 8	.120 7	.119 7	.118 6	.117 7
120	.116 7	.115 7	.114 8	.113 8	.112 9	.112 0	.111 1	.110 2	.109 4	.108 5
130	.107 7	.106 9	.106 1	.105 3	.104 5	.103 7	.103 0	.102 2	.101 5	.100 7
140	.100 0	.099 3	.098 6	.097 9	.097 2	.096 5	.095 9	.095 3	.094 6	.094 0
150	.093 3	.092 7	.092 1	.091 6	.090 9	.090 3	.089 7	.089 2	.088 6	.088 1
160	.087 5	.086 9	.086 4	.085 9	.085 4	.084 8	.084 4	.083 9	.083 3	.082 8
170	.082 3	.081 9	.081 4	.080 9	.080 5	.080 0	.079 5	.079 1	.078 7	.078 2
180	.077 7	.077 4	.076 8	.076 5	.076 0	.075 7	.075 3	.074 9	.074 5	.074 1
190	.073 6	.073 4	.072 9	.072 5	.072 1	.071 8	.071 4	.071 1	.070 7	.070 4

AT 15 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	15.000 0	7.500 0	5.000 0	3.750 0	3.000 0	2.500 0	2.143 0	1.875 0	1.666 7
10	1.500 0	1.363 6	1.250 0	1.153 8	1.071 4	1.000 0	.937 5	.882 3	.833 3	.789 4
20	.750 0	.714 3	.681 8	.652 2	.625 1	.600 0	.577 0	.555 6	.535 6	.517 3
30	.500 0	.484 0	.468 8	.454 5	.441 1	.428 6	.416 7	.405 4	.394 7	.384 6
40	.375 0	.365 9	.357 1	.348 9	.340 9	.333 3	.326 1	.319 2	.312 5	.306 1
50	.300 0	.294 1	.288 4	.283 1	.277 8	.272 8	.268 0	.263 1	.258 6	.254 2
60	.250 0	.245 9	.241 9	.238 1	.234 4	.230 8	.227 3	.223 9	.220 6	.217 4
70	.214 3	.211 3	.208 4	.205 5	.202 6	.200 0	.197 4	.194 9	.192 3	.190 0
80	.187 5	.185 2	.183 0	.180 8	.178 5	.176 5	.174 4	.172 4	.170 5	.168 6
90	.166 6	.165 0	.163 0	.161 3	.159 6	.157 9	.156 2	.154 6	.153 0	.151 5
100	.150 0	.148 5	.147 0	.145 6	.144 3	.142 9	.141 5	.140 3	.139 0	.137 6
110	.136 4	.135 1	.133 9	.132 8	.131 6	.130 5	.129 3	.128 1	.127 1	.126 0
120	.125 0	.124 0	.123 0	.121 9	.121 0	.120 0	.119 0	.118 1	.117 1	.116 3
130	.115 4	.114 5	.113 7	.112 8	.112 0	.111 1	.110 3	.109 5	.108 7	.107 9
140	.107 1	.106 4	.105 6	.104 9	.104 1	.103 5	.102 8	.102 0	.101 4	.100 6
150	.100 0	.099 3	.098 7	.098 0	.097 4	.096 8	.096 1	.095 5	.094 9	.094 4
160	.093 8	.093 1	.092 6	.092 0	.091 5	.090 9	.090 3	.089 9	.089 3	.088 8
170	.088 3	.087 8	.087 1	.086 7	.086 2	.085 7	.085 3	.084 8	.084 3	.083 9
180	.083 4	.082 8	.082 4	.082 0	.081 5	.081 1	.080 7	.080 3	.079 8	.079 4
190	.079 0	.078 6	.078 1	.077 8	.077 4	.076 9	.076 5	.076 2	.075 8	.075 5

AT 16 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	16.000 0	8.000 0	5.333 3	4.000 0	3.200 0	2.666 7	2.285 7	2.000 0	1.777 8
10	1.600 0	1.454 5	1.333 2	1.220 7	1.142 8	1.066 8	1.000 0	.941 1	.889 0	.842 0
20	.800 0	.761 9	.727 3	.695 7	.666 7	.640 0	.615 4	.592 6	.571 3	.551 7
30	.533 3	.516 2	.500 0	.484 8	.470 6	.457 2	.444 5	.432 4	.421 0	.410 2
40	.400 0	.390 3	.380 9	.372 1	.363 6	.355 5	.347 8	.340 5	.333 3	.326 5
50	.320 0	.313 7	.307 7	.301 9	.296 3	.290 9	.285 8	.280 7	.275 8	.271 2
60	.266 7	.262 3	.258 0	.254 0	.250 0	.246 2	.242 5	.238 8	.235 3	.231 9
70	.228 6	.225 3	.222 2	.219 2	.216 2	.213 3	.210 5	.207 8	.205 1	.202 5
80	.200 0	.197 5	.195 1	.192 8	.190 5	.188 2	.186 0	.183 9	.181 8	.179 8
90	.177 8	.175 8	.174 0	.172 0	.170 2	.168 4	.166 3	.164 9	.163 2	.161 6
100	.160 0	.158 4	.156 8	.155 3	.153 9	.152 3	.150 9	.149 5	.148 2	.146 8
110	.145 5	.144 1	.142 9	.141 6	.140 4	.139 1	.137 9	.136 7	.135 6	.134 4
120	.133 3	.132 2	.131 2	.130 0	.129 0	.128 0	.127 0	.126 0	.125 0	.124 1
130	.123 1	.122 1	.121 2	.120 5	.119 4	.118 5	.117 7	.116 8	.116 0	.115 1
140	.114 3	.113 5	.112 7	.111 9	.111 1	.110 4	.109 6	.108 9	.108 1	.107 4
150	.106 7	.105 9	.105 3	.104 6	.103 9	.103 2	.102 5	.101 9	.101 2	.100 7
160	.100 0	.099 3	.098 8	.098 1	.097 6	.097 0	.096 3	.095 8	.095 2	.094 6
170	.094 1	.093 6	.093 0	.092 5	.092 0	.091 4	.090 9	.090 4	.089 9	.089 4
180	.088 9	.088 4	.087 9	.087 4	.086 9	.086 5	.086 1	.085 7	.085 1	.084 7
190	.084 2	.083 8	.083 3	.082 9	.082 4	.082 0	.081 6	.081 3	.080 9	.080 4

AT 17 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	17.000 0	8.500 0	5.666 7	4.250 0	3.400 0	2.833 3	2.428 6	2.125 0	1.888 9
10	1.700 0	1.545 4	1.416 6	1.307 7	1.214 3	1.133 3	1.062 5	1.000 0	.944 4	.894 7
20	.850 0	.809 5	.772 7	.739 1	.708 4	.680 0	.653 9	.629 6	.607 2	.586 2
30	.566 7	.548 4	.531 3	.515 1	.500 0	.485 7	.472 2	.459 5	.447 4	.435 9
40	.425 0	.414 6	.404 8	.395 4	.386 4	.377 7	.369 6	.361 7	.354 2	.346 9
50	.340 0	.333 3	.327 0	.320 8	.314 8	.309 1	.303 6	.298 2	.293 1	.288 1
60	.283 3	.278 7	.274 2	.269 8	.265 6	.261 5	.257 6	.253 7	.250 0	.246 4
70	.242 9	.239 4	.236 1	.232 9	.229 7	.226 6	.223 7	.220 8	.217 9	.215 2
80	.212 5	.209 9	.207 3	.204 8	.202 4	.200 0	.197 7	.195 4	.193 2	.191 0
90	.188 9	.186 8	.184 8	.182 8	.180 9	.179 0	.177 1	.175 3	.173 5	.171 7
100	.170 0	.168 3	.166 6	.165 0	.163 5	.161 9	.160 4	.158 9	.157 4	.156 0
110	.154 5	.153 1	.151 8	.150 4	.149 0	.147 8	.146 5	.145 3	.144 0	.142 9
120	.141 6	.140 5	.139 3	.138 2	.137 1	.136 0	.134 9	.133 9	.132 8	.131 8
130	.130 8	.129 7	.128 8	.127 8	.126 9	.125 9	.125 0	.124 1	.123 2	.122 3
140	.121 4	.120 6	.119 7	.118 9	.118 1	.117 2	.116 4	.115 6	.114 9	.114 1
150	.113 3	.112 6	.111 8	.111 1	.110 4	.109 7	.109 0	.108 3	.107 6	.106 9
160	.106 3	.105 6	.105 0	.104 3	.103 7	.103 0	.102 3	.101 8	.101 2	.100 6
170	.100 0	.099 4	.098 8	.098 3	.097 7	.097 1	.096 6	.096 0	.095 5	.095 0
180	.094 4	.093 9	.093 4	.092 9	.092 4	.091 9	.091 4	.090 9	.090 4	.089 9
190	.089 5	.089 0	.088 5	.088 1	.087 6	.087 2	.086 7	.086 3	.085 9	.085 4

AT 18 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	18.000 0	9.000 0	6.000 0	4.500 0	3.600 0	3.000 0	2.571 4	2.250 0	2.000 0
10	1.800 0	1.636 3	1.500 0	1.384 6	1.285 7	1.200 0	1.125 0	1.058 8	1.000 0	.947 4
20	.900 0	.857 1	.818 2	.782 6	.750 0	.720 0	.692 3	.666 7	.642 9	.620 7
30	.600 0	.580 7	.562 5	.545 5	.529 4	.514 3	.500 0	.486 5	.473 7	.461 5
40	.450 0	.439 0	.428 6	.418 6	.409 1	.400 0	.391 3	.383 0	.375 0	.367 3
50	.360 0	.352 9	.346 2	.339 6	.333 3	.327 3	.321 4	.315 8	.310 3	.305 1
60	.300 0	.295 1	.290 3	.285 7	.281 3	.276 9	.272 7	.268 7	.264 7	.260 9
70	.257 1	.253 5	.250 0	.246 6	.243 2	.240 0	.236 8	.233 8	.230 8	.227 8
80	.225 0	.222 2	.219 5	.216 9	.214 3	.211 7	.209 3	.206 9	.204 5	.202 2
90	.200 0	.197 8	.195 7	.193 5	.191 5	.189 5	.187 5	.185 6	.183 7	.181 8
100	.180 0	.178 3	.176 5	.174 8	.173 1	.171 4	.169 8	.168 2	.166 7	.165 1
110	.163 6	.162 2	.160 7	.159 3	.157 9	.156 6	.155 2	.154 0	.152 5	.151 3
120	.150 0	.148 8	.147 5	.146 3	.145 2	.144 0	.142 9	.141 7	.140 6	.139 5
130	.138 5	.137 4	.136 4	.135 3	.134 3	.133 3	.132 3	.131 4	.130 5	.129 5
140	.128 5	.127 7	.126 8	.125 9	.125 0	.124 1	.123 3	.122 4	.121 6	.120 8
150	.120 0	.119 2	.118 4	.117 7	.116 9	.116 1	.115 3	.114 7	.113 9	.113 2
160	.112 5	.111 8	.111 1	.110 4	.109 8	.109 1	.108 4	.107 8	.107 1	.106 5
170	.105 9	.105 2	.104 6	.104 1	.103 4	.102 9	.102 3	.101 7	.101 1	.100 6
180	.100 0	.099 4	.098 9	.098 3	.097 8	.097 3	.096 8	.096 2	.095 7	.095 2
190	.094 7	.094 2	.093 7	.093 3	.092 7	.092 3	.091 8	.091 4	.090 9	.090 5

AT 19 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	19.000 0	9.500 0	6.333 3	4.750 0	3.800 0	3.166 7	2.714 4	2.375 0	2.111 1
10	1.900 0	1.727 2	1.583 3	1.461 5	1.357 1	1.266 7	1.187 5	1.117 6	1.055 5	1.000 0
20	.950 0	.904 7	.863 6	.826 1	.791 7	.760 0	.730 8	.703 7	.678 6	.655 2
30	.633 3	.613 0	.593 8	.575 7	.558 8	.542 9	.527 8	.513 5	.500 0	.487 2
40	.475 0	.463 4	.452 3	.441 9	.431 8	.422 2	.413 0	.404 3	.395 8	.387 7
50	.380 0	.372 6	.365 4	.358 5	.351 8	.345 5	.339 3	.333 3	.327 6	.322 0
60	.316 7	.311 5	.306 4	.301 6	.296 9	.292 3	.287 9	.283 6	.279 5	.275 4
70	.271 5	.267 6	.264 0	.260 3	.256 7	.253 2	.250 0	.246 8	.243 6	.240 5
80	.237 5	.234 6	.231 7	.229 0	.226 2	.223 5	.220 9	.218 4	.215 9	.213 5
90	.211 1	.208 8	.206 5	.204 3	.202 1	.200 0	.197 5	.195 8	.193 8	.191 9
100	.190 0	.188 1	.186 2	.184 4	.182 7	.181 0	.179 2	.177 5	.176 0	.174 3
110	.173 7	.171 1	.169 6	.168 2	.166 7	.165 2	.163 7	.162 4	.161 0	.159 6
120	.158 2	.157 0	.155 8	.154 4	.153 2	.152 0	.150 8	.149 6	.148 4	.147 3
130	.146 2	.145 0	.143 9	.142 8	.141 8	.140 7	.139 7	.138 7	.137 7	.136 7
140	.135 7	.134 7	.133 8	.132 9	.131 9	.131 0	.130 2	.129 2	.128 4	.127 4
150	.126 7	.125 8	.125 0	.124 2	.123 4	.122 6	.121 7	.121 0	.120 3	.119 5
160	.118 9	.118 0	.117 3	.116 6	.115 9	.115 2	.114 4	.113 8	.113 1	.112 4
170	.111 8	.111 2	.110 5	.109 8	.109 2	.108 6	.108 5	.107 4	.106 7	.106 1
180	.105 6	.104 8	.104 3	.103 8	.103 2	.102 7	.102 2	.101 7	.101 0	.100 6
190	.100 0	.099 5	.098 9	.098 4	.097 9	.097 4	.096 9	.096 5	.096 0	.095 5

AT 20 VOLTS LOSS.

Current.	0	1	2	3	4	5	6	7	8	9
0	∞	20.000 0	10.000 0	6.666 7	5.000 0	4.000 0	3.333 3	2.857 1	2.500 0	2.222 2
10	2.000 0	1.818 2	1.666 7	1.538 4	1.428 6	1.333 3	1.250 0	1.176 4	1.111 1	1.052 6
20	1.000 0	.952 4	.909 0	.869 6	.833 3	.800 0	.769 2	.740 8	.714 2	.689 6
30	.666 7	.645 2	.625 0	.606 0	.588 2	.571 4	.555 6	.540 5	.526 4	.512 8
40	.500 0	.487 8	.476 2	.465 2	.454 6	.444 4	.434 8	.425 6	.416 7	.408 2
50	.400 0	.392 2	.384 6	.377 4	.370 4	.363 6	.357 2	.350 8	.344 8	.339 0
60	.333 3	.327 9	.322 6	.317 5	.312 5	.307 7	.303 0	.298 5	.294 2	.289 9
70	.285 7	.281 7	.277 8	.274 0	.270 3	.266 7	.263 2	.259 7	.256 4	.253 2
80	.250 0	.246 9	.243 9	.241 0	.238 1	.235 3	.232 6	.229 9	.227 3	.224 7
90	.222 2	.219 8	.217 4	.215 1	.212 8	.210 5	.208 4	.206 2	.204 1	.202 0
100	.200 0	.198 0	.196 1	.194 2	.192 3	.190 5	.188 7	.186 9	.185 2	.183 4
110	.181 8	.180 2	.178 6	.177 0	.175 4	.173 9	.172 4	.170 9	.169 5	.168 1
120	.166 7	.165 3	.163 9	.162 6	.161 3	.160 0	.158 7	.157 5	.156 3	.155 0
130	.153 8	.152 7	.151 5	.150 4	.149 3	.148 1	.147 1	.146 0	.144 9	.143 9
140	.142 9	.141 8	.140 8	.139 9	.138 9	.137 9	.137 0	.136 1	.135 1	.134 2
150	.133 3	.132 5	.131 6	.130 7	.129 9	.129 0	.128 2	.127 4	.126 6	.125 8
160	.125 0	.124 2	.123 5	.122 7	.122 0	.121 2	.120 5	.119 8	.119 0	.118 3
170	.117 6	.117 0	.116 3	.115 6	.114 9	.114 3	.113 6	.113 0	.112 4	.111 7
180	.111 1	.110 5	.109 7	.109 3	.108 6	.108 1	.107 5	.107 0	.106 4	.105 8
190	.105 2	.104 8	.104 2	.103 6	.103 1	.102 6	.102 0	.101 6	.101 0	.100 5

TABLES SHOWING RESISTANCE OF VARIOUS SIZES OF WIRES (B. & S. GAUGE) AT DIFFERENT LENGTHS AT 70° F.

RESISTANCE OF NO. 0000 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.000 498	.000 996	.001 494	.001 992	.002 490	.002 988	.003 486	.003 984	.004 482
100	.004 980	.005 478	.005 976	.006 474	.006 972	.007 470	.007 968	.008 466	.008 964	.009 462
200	.009 960	.010 458	.010 956	.011 454	.011 952	.012 450	.012 948	.013 446	.013 944	.014 442
300	.014 940	.015 438	.015 936	.016 434	.016 932	.017 430	.017 928	.018 426	.018 924	.019 422
400	.019 920	.020 418	.020 916	.021 414	.021 912	.022 410	.022 908	.023 406	.023 904	.024 402
500	.024 900	.025 398	.025 896	.026 394	.026 892	.027 390	.027 888	.028 386	.028 884	.029 382
600	.029 880	.030 378	.030 876	.031 374	.031 872	.032 370	.032 868	.033 366	.033 864	.034 362
700	.034 860	.035 358	.035 856	.036 354	.036 852	.037 350	.037 848	.038 346	.038 844	.039 342
800	.039 840	.040 338	.040 836	.041 334	.041 832	.042 330	.042 828	.043 326	.043 824	.044 322
900	.044 820	.045 318	.045 816	.046 314	.046 812	.047 310	.047 808	.048 306	.048 804	.049 302
1 000	.049 800	.050 298	.050 796	.051 294	.051 792	.052 290	.052 788	.053 286	.053 784	.054 282
1 100	.054 780	.055 278	.055 776	.056 274	.056 772	.057 270	.057 768	.058 266	.058 764	.059 262
1 200	.059 760	.060 258	.060 756	.061 254	.061 752	.062 250	.062 748	.063 246	.063 744	.064 242
1 300	.064 740	.065 238	.065 736	.066 234	.066 732	.067 230	.067 728	.068 226	.068 724	.069 222
1 400	.069 720	.070 218	.070 716	.071 214	.071 712	.072 210	.072 708	.073 206	.073 704	.074 202
1 500	.074 700	.075 198	.075 696	.076 194	.076 692	.077 190	.077 688	.078 186	.078 684	.079 182
1 600	.079 680	.080 178	.080 676	.081 174	.081 672	.082 170	.082 668	.083 166	.083 664	.084 162
1 700	.084 660	.085 158	.085 656	.086 154	.086 652	.087 150	.087 648	.088 146	.088 644	.089 142
1 800	.089 640	.090 138	.090 636	.091 134	.091 632	.092 130	.092 628	.093 126	.093 624	.094 122
1 900	.094 620	.095 118	.095 616	.096 114	.096 612	.097 110	.097 608	.098 106	.098 604	.099 102

RESISTANCE OF NO. 000 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.000 628	.001 256	.001 884	.002 512	.003 140	.003 768	.004 396	.005 024	.005 652
100	.006 280	.006 908	.007 536	.008 164	.008 792	.009 420	.010 048	.010 676	.011 304	.011 932
200	.012 560	.013 188	.013 816	.014 444	.015 072	.015 700	.016 328	.016 956	.017 584	.018 212
300	.018 840	.019 468	.020 096	.020 724	.021 352	.021 980	.022 608	.023 236	.023 864	.024 492
400	.025 120	.025 748	.026 376	.027 004	.027 632	.028 260	.028 888	.029 516	.030 144	.030 772
500	.031 400	.032 028	.032 656	.033 284	.033 912	.034 540	.035 168	.035 796	.036 424	.037 052
600	.037 680	.038 308	.038 936	.039 564	.040 192	.040 820	.041 448	.042 076	.042 704	.043 332
700	.043 960	.044 588	.045 216	.045 844	.046 472	.047 100	.047 728	.048 356	.048 984	.049 612
800	.050 240	.050 868	.051 496	.052 124	.052 752	.053 380	.054 008	.054 636	.055 264	.055 892
900	.056 520	.057 148	.057 776	.058 404	.059 032	.059 660	.060 288	.060 916	.061 544	.062 172
1 000	.062 800	.063 428	.064 056	.064 684	.065 312	.065 940	.066 568	.067 196	.067 824	.068 452
1 100	.069 080	.069 708	.070 336	.070 964	.071 592	.072 220	.072 848	.073 476	.074 104	.074 732
1 200	.075 360	.075 988	.076 616	.077 244	.077 872	.078 500	.079 128	.079 756	.080 384	.081 012
1 300	.081 640	.082 268	.082 896	.083 524	.084 152	.084 780	.085 408	.086 036	.086 664	.087 292
1 400	.087 920	.088 548	.089 176	.089 804	.090 432	.091 060	.091 688	.092 316	.092 944	.093 572
1 500	.094 200	.094 828	.095 456	.096 084	.096 712	.097 340	.097 968	.098 596	.099 224	.099 852
1 600	.100 480	.101 108	.101 736	.102 364	.102 992	.103 620	.104 248	.104 876	.105 504	.106 132
1 700	.106 760	.107 388	.108 016	.108 644	.109 272	.109 900	.110 528	.111 156	.111 784	.112 412
1 800	.113 040	.113 668	.114 296	.114 924	.115 552	.116 180	.116 808	.117 436	.118 064	.118 692
1 900	.119 320	.119 948	.120 576	.121 204	.121 832	.122 460	.123 088	.123 716	.124 344	.124 972

RESISTANCE OF NO. 00 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.000 791	.001 582	.002 373	.003 164	.003 955	.004 746	.005 537	.006 328	.007 119
100	.007 910	.008 701	.009 492	.010 283	.011 074	.011 865	.012 656	.013 447	.014 238	.015 029
200	.015 820	.016 611	.017 402	.018 193	.018 984	.019 775	.020 566	.021 357	.022 148	.022 939
300	.023 730	.024 521	.025 312	.026 103	.026 894	.027 685	.028 476	.029 267	.030 058	.030 849
400	.031 640	.032 431	.033 222	.034 013	.034 804	.035 595	.036 386	.037 177	.037 968	.038 759
500	.039 550	.040 341	.041 132	.041 923	.042 714	.043 505	.044 296	.045 087	.045 878	.046 669
600	.047 460	.048 251	.049 042	.049 833	.050 624	.051 415	.052 206	.052 997	.053 788	.054 579
700	.055 370	.056 161	.056 952	.057 743	.058 534	.059 325	.060 116	.060 907	.061 698	.062 489
800	.063 280	.064 071	.064 862	.065 653	.066 444	.067 235	.068 026	.068 817	.069 608	.070 399
900	.071 190	.071 981	.072 772	.073 563	.074 354	.075 145	.075 936	.076 727	.077 518	.078 309
1 000	.079 100	.079 891	.080 682	.081 473	.082 264	.083 055	.083 846	.084 637	.085 428	.086 219
1 100	.087 010	.087 801	.088 592	.089 383	.090 174	.090 965	.091 756	.092 547	.093 338	.094 129
1 200	.094 920	.095 711	.096 502	.097 293	.098 084	.098 875	.099 666	.100 457	.101 248	.102 039
1 300	.102 830	.103 621	.104 412	.105 203	.105 994	.106 785	.107 576	.108 367	.109 158	.109 949
1 400	.110 740	.111 531	.112 322	.113 113	.113 904	.114 695	.115 486	.116 277	.117 068	.117 859
1 500	.118 650	.119 441	.120 232	.121 023	.121 814	.122 605	.123 396	.124 187	.124 978	.125 769
1 600	.126 560	.127 351	.128 142	.128 933	.129 724	.130 515	.131 306	.132 097	.132 888	.133 679
1 700	.134 470	.135 261	.136 052	.136 843	.137 634	.138 425	.139 216	.140 007	.140 798	.141 589
1 800	.142 380	.143 171	.143 962	.144 753	.145 544	.146 335	.147 126	.147 917	.148 708	.149 499
1 900	.150 290	.151 081	.151 872	.152 663	.153 454	.154 245	.155 036	.155 827	.156 618	.157 409

RESISTANCE OF NO. 0 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.000 998	.001 996	.002 994	.003 992	.004 990	.005 988	.006 986	.007 984	.008 982
100	.009 980	.010 978	.011 976	.012 974	.013 972	.014 970	.015 968	.016 966	.017 964	.018 962
200	.019 960	.020 958	.021 956	.022 954	.023 952	.024 950	.025 948	.026 946	.027 944	.028 942
300	.029 940	.030 938	.031 936	.032 934	.033 932	.034 930	.035 928	.036 926	.037 924	.038 922
400	.039 920	.040 918	.041 916	.042 914	.043 912	.044 910	.045 908	.046 906	.047 904	.048 902
500	.049 900	.050 898	.051 896	.052 894	.053 892	.054 890	.055 888	.056 886	.057 884	.058 882
600	.059 880	.060 878	.061 876	.062 874	.063 872	.064 870	.065 868	.066 866	.067 864	.068 862
700	.069 860	.070 858	.071 856	.072 854	.073 852	.074 850	.075 848	.076 846	.077 844	.078 842
800	.079 840	.080 838	.081 836	.082 834	.083 832	.084 830	.085 828	.086 826	.087 824	.088 822
900	.089 820	.090 818	.091 816	.092 814	.093 812	.094 810	.095 808	.096 806	.097 804	.098 802
1 000	.099 800	.100 798	.101 796	.102 794	.103 792	.104 790	.105 788	.106 786	.107 784	.108 782
1 100	.109 780	.110 778	.111 776	.112 774	.113 772	.114 770	.115 768	.116 766	.117 764	.118 762
1 200	.119 760	.120 758	.121 756	.122 754	.123 752	.124 750	.125 748	.126 746	.127 744	.128 742
1 300	.129 740	.130 738	.131 736	.132 734	.133 732	.134 730	.135 728	.136 726	.137 724	.138 722
1 400	.139 720	.140 718	.141 716	.142 714	.143 712	.144 710	.145 708	.146 706	.147 704	.148 702
1 500	.149 700	.150 698	.151 696	.152 694	.153 692	.154 690	.155 688	.156 686	.157 684	.158 682
1 600	.159 680	.160 678	.161 676	.162 674	.163 672	.164 670	.165 668	.166 666	.167 664	.168 662
1 700	.169 660	.170 658	.171 656	.172 654	.173 652	.174 650	.175 648	.176 646	.177 644	.178 642
1 800	.179 640	.180 638	.181 636	.182 634	.183 632	.184 630	.185 628	.186 626	.187 624	.188 622
1 900	.189 620	.190 618	.191 616	.192 614	.193 612	.194 610	.195 608	.196 606	.197 604	.198 602

RESISTANCE OF NO. 1 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.001 259	.002 518	.003 777	.005 036	.006 295	.007 554	.008 813	.010 072	.011 331
100	.012 590	.013 849	.015 108	.016 367	.017 626	.018 885	.020 144	.021 403	.022 662	.023 921
200	.025 180	.026 439	.027 698	.028 957	.030 216	.031 475	.032 734	.033 993	.035 252	.036 511
300	.037 770	.039 029	.040 288	.041 547	.042 806	.044 065	.045 324	.046 583	.047 842	.049 101
400	.050 360	.051 619	.052 878	.054 137	.055 396	.056 655	.057 914	.059 173	.060 432	.061 691
500	.062 950	.064 209	.065 468	.066 727	.067 986	.069 245	.070 504	.071 763	.073 022	.074 281
600	.075 540	.076 799	.078 058	.079 317	.080 576	.081 835	.083 094	.084 353	.085 612	.086 871
700	.088 130	.089 389	.090 648	.091 907	.093 166	.094 425	.095 684	.096 943	.098 202	.099 461
800	.100 720	.101 979	.103 238	.104 497	.105 756	.107 015	.108 274	.109 533	.110 792	.112 051
900	.113 310	.114 569	.115 828	.117 087	.118 346	.119 605	.120 864	.122 123	.123 382	.124 641
1 000	.125 900	.127 159	.128 418	.129 677	.130 936	.132 195	.133 454	.134 713	.135 972	.137 231
1 100	.138 490	.139 749	.141 008	.142 267	.143 526	.144 785	.146 044	.147 303	.148 562	.149 821
1 200	.151 080	.152 339	.153 598	.154 857	.156 116	.157 375	.158 634	.159 893	.161 152	.162 411
1 300	.163 670	.164 929	.166 188	.167 447	.168 706	.169 965	.171 224	.172 483	.173 742	.175 001
1 400	.176 260	.177 519	.178 778	.180 037	.181 296	.182 555	.183 814	.185 073	.186 332	.187 591
1 500	.188 850	.190 109	.191 368	.192 627	.193 886	.195 145	.196 404	.197 663	.198 922	.200 181
1 600	.201 440	.202 699	.203 958	.205 217	.206 476	.207 735	.208 994	.210 253	.211 512	.212 771
1 700	.214 030	.215 289	.216 548	.217 807	.219 066	.220 325	.221 584	.222 843	.224 102	.225 361
1 800	.226 620	.227 879	.229 138	.230 397	.231 656	.232 915	.234 174	.235 433	.236 692	.237 951
1 900	.239 210	.240 469	.241 728	.242 987	.244 246	.245 505	.246 764	.248 023	.249 282	.250 541

RESISTANCE OF NO. 2 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.001 587	.003 174	.004 761	.006 348	.007 935	.009 522	.011 109	.012 696	.014 283
100	.015 870	.017 457	.019 044	.020 631	.022 218	.023 805	.025 392	.026 979	.028 566	.030 153
200	.031 740	.033 327	.034 914	.036 501	.038 088	.039 675	.041 262	.042 849	.044 436	.046 023
300	.047 610	.049 197	.050 784	.052 371	.053 958	.055 545	.057 132	.058 719	.060 306	.061 893
400	.063 480	.065 067	.066 654	.068 241	.069 828	.071 415	.073 002	.074 589	.076 176	.077 763
500	.079 350	.080 937	.082 524	.084 111	.085 698	.087 285	.088 872	.090 459	.092 046	.093 633
600	.095 220	.096 807	.098 394	.099 981	.101 568	.103 155	.104 742	.106 329	.107 916	.109 503
700	.111 090	.112 677	.114 264	.115 851	.117 438	.119 025	.120 612	.122 199	.123 786	.125 373
800	.126 960	.128 547	.130 134	.131 721	.133 308	.134 895	.136 482	.138 069	.139 656	.141 243
900	.142 830	.144 417	.146 004	.147 591	.149 178	.150 765	.152 352	.153 939	.155 526	.157 113
1 000	.158 700	.160 287	.161 874	.163 461	.165 048	.166 635	.168 222	.169 809	.171 396	.172 983
1 100	.174 570	.176 157	.177 744	.179 331	.180 918	.182 505	.184 092	.185 679	.187 266	.188 853
1 200	.190 440	.192 027	.193 614	.195 201	.196 788	.198 375	.199 962	.201 549	.203 136	.204 723
1 300	.206 310	.207 897	.209 484	.211 071	.212 658	.214 245	.215 832	.217 419	.219 006	.220 593
1 400	.222 180	.223 767	.225 354	.226 941	.228 528	.230 115	.231 702	.233 289	.234 876	.236 463
1 500	.238 050	.239 637	.241 224	.242 811	.244 398	.245 985	.247 572	.249 159	.250 746	.252 333
1 600	.253 920	.255 507	.257 094	.258 681	.260 268	.261 855	.263 442	.265 029	.266 616	.268 203
1 700	.269 790	.271 377	.272 964	.274 551	.276 138	.277 725	.279 312	.280 899	.282 486	.284 073
1 800	.285 660	.287 247	.288 834	.290 421	.292 008	.293 595	.295 182	.296 769	.298 356	.299 943
1 900	.301 530	.303 117	.304 704	.306 291	.307 878	.309 465	.311 052	.312 639	.314 226	.315 813

RESISTANCE OF NO. 3 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.002 000	.004 000	.006 000	.008 000	.010 000	.012 000	.014 000	.016 000	.018 000
100	.020 000	.022 000	.024 000	.026 000	.028 000	.030 000	.032 000	.034 000	.036 000	.038 000
200	.040 000	.042 000	.044 000	.046 000	.048 000	.050 000	.052 000	.054 000	.056 000	.058 000
300	.060 000	.062 000	.064 000	.066 000	.068 000	.070 000	.072 000	.074 000	.076 000	.078 000
400	.080 000	.082 000	.084 000	.086 000	.088 000	.090 000	.092 000	.094 000	.096 000	.098 000
500	.100 000	.102 000	.104 000	.106 000	.108 000	.110 000	.112 000	.114 000	.116 000	.118 000
600	.120 000	.122 000	.124 000	.126 000	.128 000	.130 000	.132 000	.134 000	.136 000	.138 000
700	.140 000	.142 000	.144 000	.146 000	.148 000	.150 000	.152 000	.154 000	.156 000	.158 000
800	.160 000	.162 000	.164 000	.166 000	.168 000	.170 000	.172 000	.174 000	.176 000	.178 000
900	.180 000	.182 000	.184 000	.186 000	.188 000	.190 000	.192 000	.194 000	.196 000	.198 000
1 000	.200 000	.202 000	.204 000	.206 000	.208 000	.210 000	.212 000	.214 000	.216 000	.218 000
1 100	.220 000	.222 000	.224 000	.226 000	.228 000	.230 000	.232 000	.234 000	.236 000	.238 000
1 200	.240 000	.242 000	.244 000	.246 000	.248 000	.250 000	.252 000	.254 000	.256 000	.258 000
1 300	.260 000	.262 000	.264 000	.266 000	.268 000	.270 000	.272 000	.274 000	.276 000	.278 000
1 400	.280 000	.282 000	.284 000	.286 000	.288 000	.290 000	.292 000	.294 000	.296 000	.298 000
1 500	.300 000	.302 000	.304 000	.306 000	.308 000	.310 000	.312 000	.314 000	.316 000	.318 000
1 600	.320 000	.322 000	.324 000	.326 000	.328 000	.330 000	.332 000	.334 000	.336 000	.338 000
1 700	.340 000	.342 000	.344 000	.346 000	.348 000	.350 000	.352 000	.354 000	.356 000	.358 000
1 800	.360 000	.362 000	.364 000	.366 000	.368 000	.370 000	.372 000	.374 000	.376 000	.378 000
1 900	.380 000	.382 000	.384 000	.386 000	.388 000	.390 000	.392 000	.394 000	.396 000	.398 000

RESISTANCE OF NO. 4 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.002 524	.005 048	.007 572	.010 096	.012 620	.015 144	.017 668	.020 192	.022 716
100	.025 240	.027 764	.030 288	.032 812	.035 336	.037 860	.040 384	.042 908	.045 432	.047 956
200	.050 480	.053 004	.055 528	.058 052	.060 576	.063 100	.065 624	.068 148	.070 672	.073 196
300	.075 720	.078 244	.080 768	.083 392	.085 916	.088 440	.090 964	.093 488	.095 912	.098 436
400	.100 960	.103 484	.106 008	.108 532	.111 056	.113 580	.116 104	.118 628	.121 152	.123 676
500	.126 200	.128 724	.131 248	.133 772	.136 296	.138 820	.141 344	.143 868	.146 392	.148 916
600	.151 440	.153 964	.156 488	.159 012	.161 536	.164 060	.166 584	.169 108	.171 632	.174 156
700	.176 680	.179 204	.181 728	.184 252	.186 776	.189 300	.191 824	.194 348	.196 872	.199 396
800	.201 920	.204 444	.206 968	.209 492	.212 016	.214 540	.217 064	.219 588	.222 112	.224 636
900	.227 160	.229 684	.232 208	.234 732	.237 256	.239 780	.242 304	.244 828	.247 352	.249 876
1 000	.252 400	.254 924	.257 448	.259 972	.262 496	.265 020	.267 544	.270 068	.272 592	.275 116
1 100	.277 640	.280 164	.282 688	.285 212	.287 736	.290 260	.292 784	.295 308	.297 832	.300 356
1 200	.302 880	.305 404	.307 928	.310 452	.312 976	.315 500	.318 024	.320 548	.323 072	.325 596
1 300	.328 120	.330 644	.333 168	.335 692	.338 216	.340 740	.343 264	.345 788	.348 312	.350 836
1 400	.353 360	.355 884	.358 408	.360 932	.363 456	.365 980	.368 504	.371 028	.373 552	.376 076
1 500	.378 600	.381 124	.383 648	.386 172	.388 696	.391 220	.393 744	.396 268	.398 792	.401 316
1 600	.403 840	.406 364	.408 888	.411 412	.413 936	.416 460	.418 984	.421 508	.424 032	.426 556
1 700	.429 080	.431 604	.434 128	.436 652	.439 176	.441 700	.444 224	.446 748	.449 272	.451 796
1 800	.454 320	.456 844	.459 368	.461 892	.464 416	.466 940	.469 464	.471 988	.474 512	.477 036
1 900	.479 560	.482 084	.484 608	.487 132	.489 656	.492 180	.494 704	.497 228	.499 752	.502 276

RESISTANCE OF NO. 5 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.003 183	.006 366	.009 549	.012 732	.015 915	.019 098	.022 281	.025 464	.028 647
100	.031 830	.035 013	.038 196	.041 379	.044 562	.047 745	.050 928	.054 111	.057 294	.060 477
200	.063 660	.066 843	.070 026	.073 209	.076 392	.079 575	.082 758	.085 941	.089 124	.092 307
300	.095 490	.098 673	.101 856	.105 039	.108 222	.111 405	.114 588	.117 771	.120 954	.124 137
400	.127 320	.130 503	.133 686	.136 869	.140 052	.143 235	.146 418	.149 601	.152 784	.155 967
500	.159 150	.162 333	.165 516	.168 699	.171 882	.175 065	.178 248	.181 431	.184 614	.187 797
600	.190 980	.194 163	.197 346	.200 529	.203 712	.206 895	.210 078	.213 261	.216 444	.219 627
700	.222 810	.225 993	.229 176	.232 359	.235 542	.238 725	.241 908	.245 091	.248 274	.251 457
800	.254 640	.257 823	.261 006	.264 189	.267 372	.270 555	.273 738	.276 921	.280 104	.283 287
900	.286 470	.289 653	.292 836	.296 019	.299 202	.302 385	.305 568	.308 751	.311 934	.315 117
1 000	.318 300	.321 483	.324 666	.327 849	.331 032	.334 215	.337 398	.340 581	.343 764	.346 947
1 100	.350 130	.353 313	.356 496	.359 679	.362 862	.366 045	.369 228	.372 411	.375 594	.378 777
1 200	.381 960	.385 143	.388 326	.391 509	.394 692	.397 875	.401 058	.404 241	.407 424	.410 607
1 300	.413 790	.416 973	.420 156	.423 339	.426 522	.429 705	.432 888	.436 071	.439 254	.442 437
1 400	.445 620	.448 803	.451 986	.455 169	.458 352	.461 535	.464 718	.467 901	.471 084	.474 267
1 500	.477 450	.480 633	.483 816	.486 999	.490 182	.493 365	.496 548	.499 731	.502 914	.506 097
1 600	.509 280	.512 463	.515 646	.518 829	.522 012	.525 195	.528 378	.531 561	.534 744	.537 927
1 700	.541 110	.544 293	.547 476	.550 659	.553 842	.557 025	.560 208	.563 391	.566 574	.569 757
1 800	.572 940	.576 123	.579 306	.582 489	.585 672	.588 855	.592 038	.595 221	.598 404	.601 587
1 900	.604 770	.607 953	.611 136	.614 319	.617 502	.620 685	.623 868	.627 051	.630 234	.633 417

RESISTANCE OF NO. 6 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.004 014	.008 028	.012 042	.016 056	.020 070	.024 084	.028 098	.032 112	.036 126
100	.040 140	.044 154	.048 168	.052 182	.056 196	.060 210	.064 224	.068 238	.072 252	.076 266
200	.080 280	.084 294	.088 308	.092 322	.096 336	.100 350	.104 364	.108 378	.112 392	.116 406
300	.120 420	.124 434	.128 448	.132 462	.136 476	.140 490	.144 504	.148 518	.152 532	.156 546
400	.160 560	.164 574	.168 588	.172 602	.176 616	.180 630	.184 644	.188 658	.192 672	.196 686
500	.200 700	.204 714	.208 728	.212 742	.216 756	.220 770	.224 784	.228 798	.232 812	.236 826
600	.240 840	.244 854	.248 868	.252 882	.256 896	.260 910	.264 924	.268 938	.272 952	.276 966
700	.280 980	.284 994	.289 008	.293 022	.297 036	.301 050	.305 064	.309 078	.313 092	.317 106
800	.321 120	.325 134	.329 148	.333 162	.337 176	.341 190	.345 204	.349 218	.353 232	.357 246
900	.361 260	.365 274	.369 288	.373 302	.377 316	.381 330	.385 344	.389 358	.393 372	.397 386
1 000	.401 400	.405 414	.409 428	.413 442	.417 456	.421 470	.425 484	.429 498	.433 512	.437 526
1 100	.441 540	.445 554	.449 568	.453 582	.457 596	.461 610	.465 624	.469 638	.473 652	.477 666
1 200	.481 680	.485 694	.489 708	.493 722	.497 736	.501 750	.505 764	.509 778	.513 792	.517 806
1 300	.521 820	.525 834	.529 848	.533 862	.537 876	.541 890	.545 904	.549 918	.553 932	.557 946
1 400	.561 960	.565 974	.569 988	.574 002	.578 016	.582 030	.586 044	.590 058	.594 072	.598 086
1 500	.602 100	.606 114	.610 128	.614 142	.618 156	.622 170	.626 184	.630 198	.634 212	.638 226
1 600	.642 240	.646 254	.650 268	.654 282	.658 296	.662 310	.666 324	.670 338	.674 352	.678 366
1 700	.682 380	.686 394	.690 408	.694 422	.698 436	.702 450	.706 464	.710 478	.714 492	.718 506
1 800	.722 520	.726 534	.730 548	.734 562	.738 576	.742 590	.746 604	.750 618	.754 632	.758 646
1 900	.762 660	.766 674	.770 688	.774 702	.778 716	.782 730	.786 744	.790 758	.794 772	.798 786

RESISTANCE OF NO. 7 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.005 061	.010 122	.015 183	.020 244	.025 305	.030 366	.035 427	.040 488	.045 549
100	.050 610	.055 671	.060 732	.065 793	.070 854	.075 915	.080 976	.086 037	.091 098	.096 159
200	.101 220	.106 281	.111 342	.116 403	.121 464	.126 525	.131 586	.136 647	.141 708	.146 769
300	.151 830	.156 891	.161 952	.167 013	.172 074	.177 135	.182 196	.187 257	.192 318	.197 379
400	.202 440	.207 501	.212 562	.217 623	.222 684	.227 745	.232 806	.237 867	.242 928	.247 989
500	.253 050	.258 111	.263 172	.268 233	.273 294	.278 355	.283 416	.288 477	.293 538	.298 599
600	.303 660	.308 721	.313 782	.318 843	.323 904	.328 965	.334 026	.339 087	.344 148	.349 209
700	.354 270	.359 331	.364 392	.369 453	.374 514	.379 575	.384 636	.389 697	.394 758	.399 819
800	.404 880	.409 941	.415 002	.420 063	.425 124	.430 185	.435 246	.440 307	.445 368	.450 429
900	.455 490	.460 551	.465 612	.470 673	.475 734	.480 795	.485 856	.490 917	.495 978	.501 039
1 000	.506 100	.511 161	.516 222	.521 283	.526 344	.531 405	.536 466	.541 527	.546 588	.551 649
1 100	.556 710	.561 771	.566 832	.571 893	.576 954	.582 015	.587 076	.592 137	.597 198	.602 259
1 200	.607 320	.612 381	.617 442	.622 503	.627 564	.632 625	.637 686	.642 747	.647 808	.652 869
1 300	.657 930	.662 991	.668 052	.673 113	.678 174	.683 235	.688 296	.693 357	.698 418	.703 479
1 400	.708 540	.713 601	.718 662	.723 723	.728 784	.733 845	.738 906	.743 967	.749 028	.754 089
1 500	.759 150	.764 211	.769 272	.774 333	.779 394	.784 455	.789 516	.794 577	.799 638	.804 699
1 600	.809 760	.814 821	.819 882	.824 943	.830 004	.835 065	.840 126	.845 187	.850 248	.855 309
1 700	.860 370	.865 431	.870 492	.875 553	.880 614	.885 675	.890 736	.895 797	.900 858	.905 919
1 800	.910 980	.916 041	.921 102	.926 163	.931 224	.936 285	.941 346	.946 407	.951 468	.956 529
1 900	.961 590	.966 651	.971 712	.976 773	.981 834	.986 895	.991 956	.997 017	1.002 078	1.007 139

RESISTANCE OF NO. 8 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.006 38	.012 76	.019 14	.025 52	.031 92	.038 29	.044 67	.051 05	.057 43
100	.063 82	.070 20	.076 58	.082 96	.089 34	.095 73	.102 11	.108 49	.114 87	.121 25
200	.127 64	.134 02	.140 40	.146 78	.153 16	.159 55	.165 93	.172 31	.178 69	.185 07
300	.191 46	.197 84	.204 22	.210 60	.216 98	.223 37	.229 75	.236 13	.242 51	.248 89
400	.255 28	.261 66	.268 04	.274 42	.280 80	.287 19	.293 57	.299 95	.306 33	.312 71
500	.319 10	.325 48	.331 86	.338 24	.344 62	.351 01	.357 39	.363 77	.370 15	.376 53
600	.382 92	.389 30	.395 68	.402 06	.408 44	.414 83	.421 21	.427 59	.433 97	.440 35
700	.446 74	.453 12	.459 50	.465 88	.472 26	.478 65	.485 03	.491 41	.497 79	.504 17
800	.510 56	.516 94	.523 32	.529 70	.536 08	.542 47	.548 85	.555 23	.561 61	.567 99
900	.574 38	.580 76	.587 14	.593 52	.599 90	.606 29	.612 67	.619 05	.625 43	.631 81
1 000	.638 20	.644 58	.650 96	.657 34	.663 72	.670 11	.676 49	.682 87	.689 25	.695 63
1 100	.702 02	.708 40	.714 78	.721 16	.727 54	.733 93	.740 31	.746 69	.753 07	.759 45
1 200	.765 84	.772 22	.778 60	.784 98	.791 36	.797 75	.804 13	.810 51	.816 89	.823 27
1 300	.829 66	.836 04	.842 42	.848 80	.855 18	.861 57	.867 95	.874 33	.880 71	.887 09
1 400	.893 48	.899 86	.906 24	.912 62	.919 00	.925 39	.931 77	.938 15	.944 53	.950 91
1 500	.957 30	.963 68	.970 06	.976 44	.982 82	.989 21	.995 59	1.001 97	1.008 35	1.014 73
1 600	1.021 12	1.027 50	1.033 88	1.040 26	1.046 64	1.053 03	1.059 41	1.065 79	1.072 17	1.078 55
1 700	1.084 94	1.091 32	1.097 70	1.104 08	1.110 46	1.116 85	1.123 23	1.129 61	1.135 99	1.142 37
1 800	1.148 76	1.155 14	1.161 52	1.167 90	1.174 28	1.180 67	1.187 05	1.193 43	1.199 81	1.206 19
1 900	1.212 58	1.218 96	1.225 34	1.231 72	1.238 10	1.244 49	1.250 87	1.257 25	1.263 63	1.270 01

RESISTANCE OF NO. 9 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.008 04	.016 09	.024 13	.032 18	.040 23	.048 27	.056 32	.064 36	.072 41
100	.080 46	.088 50	.096 55	.104 59	.112 64	.120 69	.128 73	.136 78	.144 82	.152 87
200	.160 92	.168 96	.177 01	.185 05	.193 10	.201 15	.209 19	.217 24	.225 28	.233 33
300	.241 38	.249 42	.257 47	.265 51	.273 56	.281 61	.289 65	.297 70	.305 74	.313 79
400	.321 84	.329 88	.337 93	.345 97	.354 02	.362 07	.370 11	.378 16	.386 20	.394 25
500	.402 30	.410 34	.418 39	.426 43	.434 48	.442 53	.450 57	.458 62	.466 66	.474 71
600	.482 76	.490 80	.498 85	.506 89	.514 94	.522 99	.531 03	.539 08	.547 12	.555 17
700	.563 22	.571 26	.579 31	.587 35	.595 40	.603 45	.611 49	.619 54	.627 58	.635 63
800	.643 68	.651 72	.659 77	.667 81	.675 86	.683 91	.691 95	.700 00	.708 04	.716 09
900	.724 14	.732 18	.740 23	.748 27	.756 32	.764 37	.772 41	.780 46	.788 50	.796 55
1 000	.804 60	.812 64	.820 69	.828 73	.836 78	.844 83	.852 87	.860 92	.868 96	.877 01
1 100	.885 06	.893 10	.901 15	.909 19	.917 24	.925 29	.933 33	.941 38	.949 42	.957 47
1 200	.965 52	.973 56	.981 61	.989 65	.997 70	1.005 75	1.013 79	1.021 84	1.029 88	1.037 93
1 300	1.045 98	1.054 02	1.062 07	1.070 11	1.078 16	1.086 21	1.094 25	1.102 30	1.110 34	1.118 39
1 400	1.126 44	1.134 48	1.142 53	1.150 57	1.158 62	1.166 67	1.174 71	1.182 76	1.190 80	1.198 85
1 500	1.206 90	1.214 94	1.222 99	1.231 03	1.239 08	1.247 13	1.255 17	1.263 22	1.271 26	1.279 31
1 600	1.287 36	1.295 40	1.303 45	1.311 49	1.319 54	1.327 59	1.335 63	1.343 68	1.351 72	1.359 77
1 700	1.367 82	1.375 86	1.383 91	1.391 95	1.400 00	1.408 05	1 416 09	1.424 14	1.432 18	1.440 23
1 800	1.448 28	1.456 32	1.464 37	1.472 41	1.480 46	1.488 51	1.496 55	1.504 60	1.512 64	1.520 69
1 900	1.528 74	1.536 78	1.544 83	1.552 87	1.560 92	1.568 97	1.577 01	1.585 06	1.593 10	1.601 15

RESISTANCE OF NO. 10 COPPER WIRE.

Feet.	0	10	20	30	40	50	60	70	80	90
0		.010 15	.020 30	.030 45	.040 60	.050 75	.060 90	.071 05	.081 20	.091 35
100	.101 50	.111 65	.121 80	.131 95	.142 10	.152 25	.162 40	.172 55	.182 70	.192 85
200	.203 00	.213 15	.223 30	.233 45	.243 60	.253 75	.263 90	.274 05	.284 20	.294 35
300	.304 50	.314 65	.324 80	.334 95	.345 10	.355 25	.365 40	.375 55	.385 70	.395 85
400	.406 00	.416 15	.426 30	.436 45	.446 60	.456 75	.466 90	.477 05	.487 20	.497 35
500	.507 50	.517 65	.527 80	.537 95	.548 10	.558 25	.568 40	.578 55	.588 70	.598 85
600	.609 00	.619 15	.629 30	.639 45	.649 60	.559 75	.669 90	.680 05	.690 20	.700 35
700	.710 50	.720 65	.730 80	.740 95	.751 10	.761 25	.771 40	.781 55	.791 70	.801 85
800	.812 00	.822 15	.832 30	.842 45	.852 60	.862 75	.872 90	.883 05	.893 20	.903 35
900	.913 50	.923 65	.933 80	.943 95	.954 10	.964 25	.974 40	.984 55	.994 70	1.004 85
1 000	1.015 00	1.025 15	1.035 30	1.045 45	1.055 60	1.065 75	1.075 90	1.086 05	1.096 20	1.106 35
1 100	1.116 50	1.126 65	1.136 80	1.146 95	1.157 10	1.167 25	1.177 40	1.187 55	1.197 70	1.207 85
1 200	1.218 00	1.228 15	1.238 30	1.248 45	1.258 60	1.268 75	1.278 90	1.289 05	1.299 20	1.309 35
1 300	1.319 50	1.329 65	1.339 80	1.349 95	1.360 10	1.370 25	1.380 40	1.390 55	1.400 70	1.410 85
1 400	1.421 00	1.431 15	1.441 30	1.451 45	1.461 60	1.471 75	1.481 90	1.492 05	1.502 20	1.512 35
1 500	1.522 50	1.532 65	1.542 80	1.552 95	1.563 10	1.573 25	1.583 40	1.593 55	1.603 70	1.613 85
1 600	1.624 00	1.634 15	1.644 30	1.654 45	1.664 60	1.674 75	1.684 90	1.695 05	1.705 20	1.715 35
1 700	1.725 50	1.735 65	1.745 80	1.755 95	1.766 10	1.776 25	1.786 40	1.796 55	1.806 70	1.816 85
1 800	1.827 00	1.837 15	1.847 30	1.857 45	1.867 60	1.877 75	1.887 90	1.898 05	1.908 20	1.918 35
1 900	1.928 50	1.938 65	1.948 80	1.958 95	1.969 10	1.979 25	1.989 40	1.999 55	2.009 70	2.019 85

RESISTANCE OF NO. 11 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.001 27	.002 55	.003 83	.005 11	.006 39	.007 67	.008 95	.010 23	.011 51
10	.012 79	.014 06	.015 34	.016 62	.017 90	.019 18	.020 46	.021 74	.023 02	.024 30
20	.025 58	.026 85	.028 13	.029 41	.030 69	.031 97	.033 25	.034 53	.035 81	.037 09
30	.038 37	.039 64	.040 92	.042 20	.043 48	.044 76	.046 04	.047 32	.048 60	.049 88
40	.051 16	.052 43	.053 71	.054 99	.056 27	.057 55	.058 83	.060 11	.061 39	.062 67
50	.063 95	.065 22	.066 50	.067 78	.069 06	.070 34	.071 62	.072 90	.074 18	.075 46
60	.076 74	.078 01	.079 29	.080 57	.081 85	.083 13	.084 41	.085 69	.086 97	.088 25
70	.089 53	.090 80	.092 08	.093 36	.094 64	.095 92	.097 20	.098 48	.099 76	.101 94
80	.102 32	.103 59	.104 87	.106 15	.107 43	.108 71	.109 99	.111 27	.112 55	.113 83
90	.115 11	.116 38	.117 66	.118 94	.120 22	.121 50	.122 78	.124 06	.125 34	.126 62
100	.127 90	.129 17	.130 45	.131 73	.133 01	.134 29	.135 57	.136 85	.138 13	.139 41
110	.140 69	.141 96	.143 24	.144 52	.145 80	.147 08	.148 36	.149 64	.150 92	.152 20
120	.153 48	.154 75	.156 03	.157 31	.158 59	.159 87	.161 15	.162 43	.163 71	.164 99
130	.166 27	.167 54	.168 82	.170 10	.171 38	.172 66	.173 94	.175 22	.176 50	.177 78
140	.179 06	.180 33	.181 61	.182 89	.184 17	.185 45	.186 73	.188 01	.189 29	.190 57
150	.191 85	.193 12	.194 40	.195 68	.196 96	.198 24	.199 52	.200 80	.202 08	.203 36
160	.204 64	.205 91	.207 19	.208 47	.209 75	.211 03	.212 31	.213 59	.214 87	.216 15
170	.217 43	.218 70	.219 98	.221 26	.222 54	.223 82	.225 10	.226 38	.227 66	.228 94
180	.230 22	.231 49	.232 77	.234 05	.235 33	.236 61	.237 89	.239 17	.240 45	.241 73
190	.243 01	.244 28	.245 56	.246 84	.248 12	.249 40	.250 68	.251 96	.253 24	.254 52

RESISTANCE OF NO. 12 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.001 61	.003 22	.004 84	.006 45	.008 07	.009 68	.011 29	.012 91	.014 52
10	.016 14	.017 75	.019 36	.020 98	.022 59	.024 21	.025 82	.027 43	.029 05	.030 66
20	.032 28	.033 89	.035 50	.037 12	.038 73	.040 35	.041 96	.043 57	.045 19	.046 80
30	.048 42	.050 03	.051 64	.053 26	.054 87	.056 49	.058 10	.059 71	.061 33	.062 94
40	.064 56	.066 17	.067 78	.069 40	.071 01	.072 63	.074 24	.075 85	.077 47	.079 08
50	.080 70	.082 31	.083 92	.085 54	.087 15	.088 77	.090 38	.091 99	.093 61	.095 22
60	.096 84	.098 45	.100 06	.101 68	.103 29	.104 91	.106 52	.108 13	.109 75	.111 36
70	.112 98	.114 59	.116 20	.117 82	.119 43	.121 05	.122 66	.124 27	.125 89	.127 50
80	.129 12	.130 73	.132 34	.133 96	.135 57	.137 19	.138 80	.140 41	.142 03	.143 64
90	.145 26	.146 87	.148 48	.150 10	.151 71	.152 33	.153 94	.155 55	.157 17	.159 78
100	.161 40	.163 01	.164 62	.166 24	.167 85	.169 47	.171 08	.172 69	.174 31	.175 92
110	.177 54	.179 15	.180 76	.182 38	.183 99	.185 61	.187 22	.188 83	.190 45	.192 06
120	.193 68	.195 29	.196 90	.198 52	.200 13	.201 75	.203 36	.204 97	.206 59	.208 20
130	.209 82	.211 43	.213 04	.214 66	.216 27	.217 89	.219 50	.221 11	.222 73	.224 34
140	.225 96	.227 57	.229 18	.230 80	.232 41	.234 03	.235 64	.237 25	.238 87	.240 48
150	.242 10	.243 71	.245 32	.246 94	.248 55	.250 17	.251 78	.253 39	.255 01	.256 62
160	.258 24	.259 85	.261 46	.263 08	.264 69	.266 31	.267 92	.269 53	.271 15	.272 76
170	.274 38	.275 99	.277 60	.279 22	.280 83	.282 45	.284 06	.285 67	.287 29	.288 90
180	.290 52	.292 13	.293 74	.295 36	.296 97	.298 59	.300 20	.301 81	.303 43	.305 04
190	.306 66	.308 27	.309 88	.311 50	.313 11	.314 73	.316 34	.317 95	.319 57	.321 18

RESISTANCE OF NO. 13 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.002 03	.004 07	.006 10	.008 14	.010 17	.012 21	.014 24	.016 28	.018 31
10	.020 35	.022 38	.024 42	.026 45	.028 49	.030 52	.032 56	.034 59	.036 63	.038 66
20	.040 70	.042 73	.044 77	.046 80	.048 84	.050 87	.052 91	.054 94	.056 98	.059 01
30	.061 05	.063 08	.065 12	.067 15	.069 19	.071 22	.073 26	.075 29	.077 33	.079 36
40	.081 40	.083 43	.085 47	.087 50	.089 54	.091 57	.093 61	.095 64	.097 68	.099 71
50	.101 75	.103 78	.105 82	.107 85	.109 89	.111 92	.113 96	.115 99	.118 03	.120 06
60	.122 10	.124 13	.126 17	.128 20	.130 24	.132 27	.134 31	.136 34	.138 38	.140 41
70	.142 45	.144 48	.146 52	.148 55	.150 59	.152 62	.154 66	.156 69	.158 73	.160 76
80	.162 80	.164 83	.166 87	.168 90	.170 94	.172 97	.175 01	.177 04	.179 08	.181 11
90	.183 15	.185 18	.187 22	.189 25	.191 29	.193 32	.195 36	.197 39	.199 43	.201 46
100	.203 50	.205 53	.207 57	.209 60	.211 64	.213 67	.215 71	.217 74	.219 78	.221 81
110	.223 85	.225 88	.227 92	.229 95	.231 99	.234 02	.236 06	.238 09	.240 13	.242 16
120	.244 20	.246 23	.248 27	.250 30	.252 34	.254 37	.256 41	.258 44	.260 48	.262 51
130	.264 55	.266 58	.268 62	.270 65	.272 69	.274 72	.276 76	.278 79	.280 83	.282 86
140	.284 90	.286 93	.288 97	.291 00	.293 04	.295 07	.297 11	.299 14	.301 18	.303 21
150	.305 25	.307 28	.309 32	.311 35	.313 39	.315 42	.317 46	.319 49	.321 53	.323 56
160	.325 60	.327 63	.329 67	.331 70	.333 74	.335 77	.337 81	.339 84	.341 88	.343 91
170	.345 95	.347 98	.350 02	.352 05	.354 09	.356 12	.358 16	.360 19	.362 23	.364 26
180	.366 30	.368 33	.370 37	.372 40	.374 44	.376 47	.378 51	.380 54	.382 58	.384 61
190	.386 65	.388 68	.390 72	.392 75	.394 79	.396 82	.398 86	.400 89	.402 93	.404 96

RESISTANCE OF NO. 14 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.002 56	.005 13	.007 70	.010 26	.012 83	.015 40	.017 96	.020 53	.023 10
10	.025 67	.028 23	.030 80	.033 37	.035 93	.038 50	.041 07	.043 63	.046 20	.048 77
20	.051 34	.053 90	.056 47	.059 04	.061 60	.064 17	.066 74	.069 30	.071 87	.074 44
30	.077 01	.079 57	.082 14	.084 71	.087 27	.089 84	.092 41	.094 97	.097 54	.100 11
40	.102 68	.105 24	.107 81	.110 38	.112 94	.115 51	.118 08	.120 64	.123 21	.125 78
50	.128 35	.130 91	.133 48	.136 05	.138 61	.141 18	.143 75	.146 31	.148 88	.151 45
60	.154 02	.156 58	.159 15	.161 72	.164 28	.166 85	.169 42	.171 98	.174 55	.177 12
70	.179 69	.182 25	.184 82	.187 39	.189 95	.192 52	.195 09	.197 65	.200 22	.202 79
80	.205 36	.207 92	.210 49	.213 06	.215 62	.218 19	.220 76	.223 32	.225 89	.237 46
90	.231 03	.233 59	.236 16	.238 73	.241 29	.243 86	.246 43	.248 99	.251 56	.254 13
100	.256 70	.259 26	.261 83	.264 40	.266 96	.269 53	.272 10	.274 66	.277 23	.279 80
110	.282 37	.284 93	.287 50	.290 07	.292 63	.295 20	.297 77	.300 33	.302 90	.305 47
120	.308 04	.310 60	.313 17	.315 74	.318 30	.320 87	.323 44	.326 00	.328 57	.331 14
130	.333 71	.336 27	.338 84	.341 41	.343 97	.346 54	.349 11	.351 67	.354 24	.356 81
140	.359 38	.361 94	.364 51	.367 08	.369 64	.372 21	.374 78	.377 34	.379 91	.382 48
150	.385 05	.387 61	.390 18	.392 75	.395 31	.397 88	.400 45	.403 01	.405 58	.408 15
160	.410 72	.413 28	.415 85	.418 42	.420 98	.423 55	.426 12	.428 68	.431 25	.433 82
170	.436 39	.438 95	.441 52	.444 09	.446 65	.449 22	.451 79	.454 35	.456 92	.459 49
180	.462 06	.464 62	.467 19	.469 76	.472 32	.474 89	.477 46	.480 02	.482 59	.485 16
190	.487 73	.490 29	.492 86	.495 43	.497 99	.500 56	.503 13	.505 69	.508 26	.510 83

RESISTANCE OF NO. 15 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.003 23	.006 47	.009 70	.012 94	.016 17	.019 41	.022 64	.025 88	.029 11
10	.032 35	.035 58	.038 82	.042 05	.045 29	.048 52	.051 76	.054 99	.058 23	.061 46
20	.064 70	.067 93	.071 17	.074 40	.077 64	.080 87	.084 11	.087 34	.090 58	.093 81
30	.097 05	.100 28	.103 52	.106 75	.109 99	.113 22	.116 46	.119 69	.122 93	.126 16
40	.129 40	.132 63	.135 87	.139 10	.142 34	.145 57	.148 81	.152 04	.155 28	.158 51
50	.161 75	.164 98	.168 22	.171 45	.174 69	.177 92	.181 16	.184 39	.187 63	.190 86
60	.194 10	.197 33	.200 57	.203 80	.207 04	.210 27	.213 51	.216 74	.219 98	.223 21
70	.226 45	.229 68	.232 92	.236 15	.239 39	.242 62	.245 86	.249 09	.252 33	.255 56
80	.258 80	.262 03	.265 27	.268 50	.271 74	.274 97	.278 21	.281 44	.284 68	.287 91
90	.291 15	.294 38	.297 62	.300 85	.304 09	.307 32	.310 56	.313 79	.317 03	.320 26
100	.323 50	.326 73	.329 97	.333 20	.336 44	.339 67	.342 91	.346 14	.349 38	.352 61
110	.355 85	.359 08	.362 32	.365 55	.368 79	.372 02	.375 26	.378 49	.381 73	.384 96
120	.388 20	.391 43	.394 67	.397 90	.401 14	.404 37	.407 61	.410 84	.414 08	.417 31
130	.420 55	.423 78	.427 02	.430 25	.433 49	.436 72	.439 96	.443 19	.446 43	.449 66
140	.452 90	.456 13	.459 37	.462 60	.465 84	.469 07	.472 31	.475 54	.478 78	.482 01
150	.485 25	.488 48	.491 72	.494 95	.498 19	.501 42	.504 66	.507 89	.511 13	.514 36
160	.517 60	.520 83	.524 07	.527 30	.530 54	.533 77	.537 01	.540 24	.543 48	.546 71
170	.549 95	.553 18	.556 42	.559 65	.562 89	.566 12	.569 36	.572 59	.575 83	.579 06
180	.582 30	.585 53	.588 77	.592 00	.595 24	.598 47	.601 71	.604 94	.608 18	.611 41
190	.614 65	.617 88	.621 12	.624 35	.627 59	.630 82	.634 06	.637 29	.640 53	.643 76

RESISTANCE OF NO. 16 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.004 08	.008 16	.012 24	.016 32	.020 40	.024 48	.028 56	.032 64	.036 72
10	.040 80	.044 88	.048 96	.053 04	.057 12	.061 20	.065 28	.069 36	.073 44	.077 52
20	.081 60	.085 68	.089 76	.093 84	.097 92	.102 00	.106 08	.110 16	.114 24	.118 32
30	.122 40	.126 48	.130 56	.134 64	.138 72	.142 80	.146 88	.150 96	.155 04	.159 12
40	.163 20	.167 28	.171 36	.175 44	.179 52	.183 60	.187 68	.191 76	.195 84	.199 92
50	.204 00	.208 08	.212 16	.216 24	.220 32	.224 40	.228 48	.232 56	.236 64	.240 72
60	.244 80	.248 88	.252 96	.257 04	.261 12	.265 20	.269 28	.273 36	.277 44	.281 52
70	.285 60	.289 68	.293 76	.297 84	.301 92	.306 00	.310 08	.314 16	.318 24	.322 32
80	.326 40	.330 48	.334 56	.338 64	.342 72	.346 80	.350 88	.354 96	.359 04	.363 12
90	.367 20	.371 28	.375 36	.379 44	.383 52	.387 60	.391 68	.395 76	.399 84	.403 92
100	.408 00	.412 08	.416 16	.420 24	.424 32	.428 40	.432 48	.436 56	.440 64	.444 72
110	.448 80	.452 88	.456 96	.461 04	.465 12	.469 20	.473 28	.477 36	.481 44	.485 52
120	.489 60	.493 68	.497 76	.501 84	.505 92	.510 00	.514 08	.518 16	.522 24	.526 32
130	.530 40	.534 48	.538 56	.542 64	.546 72	.550 80	.554 88	.558 96	.563 04	.567 12
140	.571 20	.575 28	.579 36	.583 44	.587 52	.591 60	.595 68	.599 76	.603 84	.607 92
150	.612 00	.616 08	.620 16	.624 24	.628 32	.632 40	.636 48	.640 56	.644 64	.648 72
160	.652 80	.656 88	.660 96	.665 04	.669 12	.673 20	.677 28	.681 36	.685 44	.689 52
170	.693 60	.697 68	.701 76	.705 84	.709 92	.714 00	.718 08	.722 16	.726 24	.730 32
180	.734 40	.738 48	.742 56	.746 64	.750 72	.754 80	.758 88	.762 96	.767 04	.771 12
190	.775 20	.779 28	.783 36	.787 44	.791 52	.795 60	.799 68	.803 76	.807 84	.811 92

RESISTANCE OF NO. 17 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.005 14	.010 28	.015 43	.020 57	.025 72	.030 86	.036 00	.041 15	.046 29
10	.051 44	.056 58	.061 72	.066 87	.072 01	.077 16	.082 30	.087 44	.092 59	.097 73
20	.102 88	.108 02	.113 16	.118 31	.123 45	.128 60	.133 74	.138 88	.144 03	.149 17
30	.154 32	.159 46	.164 60	.169 75	.174 89	.180 04	.185 18	.190 32	.195 47	.200 61
40	.205 76	.210 90	.216 04	.221 19	.226 33	.231 48	.236 62	.241 76	.246 91	.252 05
50	.257 20	.262 34	.267 48	.272 63	.277 77	.282 92	.288 06	.293 20	.298 35	.303 49
60	.308 64	.313 78	.318 92	.324 07	.329 21	.334 36	.339 50	.344 64	.349 79	.354 93
70	.360 08	.365 22	.370 36	.375 51	.380 65	.385 80	.390 94	.396 08	.401 23	.406 37
80	.411 52	.416 66	.421 80	.426 95	.432 09	.437 24	.442 38	.447 52	.452 67	.457 81
90	.462 96	.468 10	.473 24	.478 39	.483 53	.488 68	.493 82	.498 96	.504 11	.509 25
100	.514 40	.519 54	.524 68	.529 83	.534 97	.540 12	.545 26	.550 40	.555 55	.560 69
110	.565 84	.570 98	.576 12	.581 27	.586 41	.591 56	.596 70	.601 84	.606 99	.612 13
120	.617 28	.622 42	.627 56	.632 71	.637 85	.643 00	.648 14	.653 28	.658 43	.663 57
130	.668 72	.673 86	.679 00	.684 15	.689 29	.694 44	.699 58	.704 72	.709 87	.715 01
140	.720 16	.725 30	.730 44	.735 59	.740 73	.745 88	.751 02	.756 16	.761 31	.766 45
150	.771 60	.776 74	.781 88	.787 03	.792 17	.797 32	.802 46	.807 60	.812 75	.817 89
160	.823 04	.828 18	.833 32	.838 47	.843 61	.848 76	.853 90	.859 04	.864 19	.869 33
170	.874 48	.879 62	.884 76	.889 91	.895 05	.900 20	.905 34	.910 48	.915 63	.920 77
180	.925 92	.931 06	.936 20	.941 35	.946 49	.951 64	.956 78	.961 92	.967 07	.972 21
190	.977 36	.982 50	.987 64	.992 79	.997 93	1.003 08	1.008 22	1.013 36	1.018 51	1.023 65

RESISTANCE OF NO. 18 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.006 42	.012 85	.019 27	.025 70	.032 12	.038 55	.044 97	.051 40	.057 82
10	.064 25	.070 67	.077 10	.083 52	.089 95	.096 37	.102 80	.109 22	.115 65	.122 07
20	.128 50	.134 92	.141 35	.147 77	.154 20	.160 62	.167 05	.173 47	.179 90	.186 32
30	.192 75	.199 17	.205 60	.212 02	.218 45	.224 87	.231 30	.237 72	.244 15	.250 57
40	.257 00	.263 42	.269 85	.276 27	.282 70	.289 12	.295 55	.301 97	.308 40	.314 82
50	.321 25	.327 67	.334 10	.340 52	.346 95	.353 37	.359 80	.366 22	.372 65	.379 07
60	.385 50	.391 92	.398 35	.404 77	.411 20	.417 62	.424 05	.430 47	.436 90	.443 32
70	.449 75	.456 17	.462 60	.469 02	.475 45	.481 87	.488 30	.494 72	.501 15	.507 57
80	.514 00	.520 42	.526 85	.533 27	.539 70	.546 12	.552 55	.558 97	.565 40	.571 82
90	.578 25	.584 67	.591 10	.597 52	.603 95	.610 37	.616 80	.623 22	.629 65	.636 07
100	.642 50	.648 92	.655 35	.661 77	.668 20	.674 62	.681 05	.687 47	.693 90	.700 32
110	.706 75	.713 17	.719 60	.726 02	.732 45	.738 87	.745 30	.751 72	.758 15	.764 57
120	.771 00	.777 42	.783 85	.790 27	.796 70	.803 12	.809 55	.815 97	.822 40	.828 82
130	.835 25	.841 67	.848 10	.854 52	.860 95	.867 37	.873 80	.880 22	.886 65	.893 07
140	.899 50	.905 92	.912 35	.918 77	.925 20	.931 62	.938 05	.944 47	.950 90	.957 32
150	.963 75	.970 17	.976 60	.983 02	.989 45	.995 87	1.002 30	1.008 72	1.015 15	1.021 57
160	1.028 00	1.034 42	1.040 85	1.047 27	1.053 70	1.060 12	1.066 55	1.072 97	1.079 40	1.085 82
170	1.092 25	1.098 67	1.105 10	1.111 52	1.117 95	1.124 37	1.130 80	1.137 22	1.143 65	1.150 07
180	1.156 50	1.162 92	1.169 35	1.175 77	1.182 20	1.188 62	1.195 05	1.201 47	1.207 90	1.214 32
190	1.220 75	1.227 17	1.233 60	1.240 02	1.246 45	1.252 87	1.259 30	1.265 72	1.272 15	1.278 57

RESISTANCE OF NO. 19 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.008 18	.016 36	.024 54	.032 72	.040 90	.049 08	.057 26	.065 44	.073 62
10	.081 80	.089 98	.098 16	.106 34	.114 52	.122 70	.130 88	.139 06	.147 24	.155 42
20	.163 60	.171 78	.179 96	.188 14	.196 32	.204 50	.212 68	.220 86	.229 04	.237 22
30	.245 40	.253 58	.261 76	.269 94	.278 12	.286 30	.294 48	.302 66	.310 84	.319 02
40	.327 20	.335 38	.343 56	.351 74	.359 92	.368 10	.376 28	.384 46	.392 64	.400 82
50	.409 00	.417 18	.425 36	.433 54	.441 72	.449 90	.458 08	.466 26	.474 44	.482 62
60	.490 80	.498 98	.507 16	.515 34	.523 52	.531 70	.539 88	.548 06	.556 24	.564 42
70	.572 60	.580 78	.588 96	.597 14	.605 32	.613 50	.621 68	.629 86	.638 04	.646 22
80	.654 40	.662 58	.670 76	.678 94	.687 12	.695 30	.703 48	.711 66	.719 84	.728 02
90	.736 20	.744 38	.752 56	.760 74	.768 92	.777 10	.785 28	.793 46	.801 64	.809 82
100	.818 00	.826 18	.834 36	.842 54	.850 72	.858 90	.867 08	.875 26	.883 44	.891 62
110	.899 80	.907 98	.916 16	.924 34	.932 52	.940 70	.948 88	.957 06	.965 24	.973 42
120	.981 60	.989 78	.997 96	1.006 14	1.014 32	1.022 50	1.030 68	1.038 86	1.047 04	1.055 22
130	1.063 40	1.071 58	1.079 76	1.087 94	1.096 12	1.104 30	1.112 48	1.120 66	1.128 84	1.137 02
140	1.145 20	1.153 38	1.161 56	1.169 74	1.177 92	1.186 10	1.194 28	1.202 46	1.210 64	1.218 82
150	1.227 00	1.235 18	1.243 36	1.251 54	1.259 72	1.267 90	1.276 08	1.284 26	1.292 44	1.300 62
160	1.308 80	1.316 98	1.325 16	1.333 34	1.341 52	1.349 70	1.357 88	1.366 06	1.374 24	1.382 42
170	1.390 60	1.398 78	1.406 96	1.415 14	1.423 32	1.431 50	1.439 68	1.447 86	1.456 04	1.464 22
180	1.472 40	1.480 58	1.488 76	1.496 94	1.505 12	1.513 30	1.521 48	1.529 66	1.537 84	1.546 02
190	1.554 20	1.562 38	1.570 56	1.578 74	1.586 92	1.595 10	1.603 28	1.611 46	1.619 64	1.627 82

RESISTANCE OF NO. 20 COPPER WIRE.

Feet.	0	1	2	3	4	5	6	7	8	9
0		.010 31	.020 62	.030 93	.041 24	.051 55	.061 86	.072 17	.082 48	.092 79
10	.103 10	.113 41	.123 72	.134 03	.144 34	.154 65	.164 96	.175 27	.185 58	.195 89
20	.206 20	.216 51	.226 82	.237 13	.247 44	.257 75	.268 06	.278 37	.288 68	.298 99
30	.309 30	.319 61	.329 92	.340 23	.350 54	.360 85	.371 16	.381 47	.391 78	.402 09
40	.412 40	.422 71	.433 02	.443 33	.453 64	.463 95	.474 26	.484 57	.494 88	.505 19
50	.515 50	.525 81	.536 12	.546 43	.556 74	.567 05	.577 36	.587 67	.597 98	.608 29
60	.618 60	.628 91	.639 22	.649 53	.659 84	.670 15	.680 46	.690 77	.701 08	.711 39
70	.721 70	.732 01	.742 32	.752 63	.762 94	.773 25	.783 56	.793 87	.804 18	.814 49
80	.824 80	.835 11	.845 42	.855 73	.866 04	.876 35	.886 66	.896 97	.907 28	.917 59
90	.927 90	.938 21	.948 52	.958 83	.969 14	.979 45	.989 76	1.000 07	1.010 38	1.020 69
100	1.031 00	1.041 31	1.051 62	1.061 93	1.072 24	1.082 55	1.092 86	1.103 17	1.113 48	1.123 79
110	1.134 10	1.144 41	1.154 72	1.165 03	1.175 34	1.185 65	1.195 96	1.206 27	1.216 58	1.226 89
120	1.237 20	1.247 51	1.257 82	1.268 13	1.278 44	1.288 75	1.299 06	1.309 37	1.319 68	1.329 99
130	1.340 30	1.350 61	1.360 92	1.371 23	1.381 54	1.391 85	1.402 16	1.412 47	1.422 78	1.433 09
140	1.443 40	1.453 71	1.464 02	1.474 33	1.484 64	1.494 95	1.505 26	1.515 57	1.525 88	1.536 19
150	1.546 50	1.556 81	1.567 12	1.577 43	1.587 74	1.598 05	1.608 36	1.618 67	1.628 98	1.639 29
160	1.649 60	1.659 91	1.670 22	1.680 53	1.690 84	1.701 15	1.711 46	1.721 77	1.732 08	1.742 39
170	1.752 70	1.763 01	1.773 32	1.783 63	1.793 94	1.804 25	1.814 56	1.824 87	1.835 18	1.845 49
180	1.855 80	1.866 11	1.876 42	1.886 73	1.897 04	1.907 35	1.917 66	1.927 97	1.938 28	1.948 59
190	1.958 90	1.969 21	1.979 52	1.989 83	2.000 14	2.010 45	2.020 76	2.031 07	2.041 38	2.051 69

WIRING CHART.

The resistance in any circuit may be determined either by the length and size of the conductor composing it, or by the current and fall of potential along the conductor. In the first case, the resistance is directly as the length and inversely as the cross-section. In the second, it is directly as the fall of potential and inversely as the current.

The consideration of these principles has led to a graphic method of determining the sizes of wire necessary to carry certain currents over any given distance when the fall of potential is known. To say that the resistance is directly as one quantity and inversely as another, determines that if these quantities be plotted along any pair of rectangular coördinates, then lines of equal resistance will be straight lines radiating from the origin of the coördinates, and if these two separate sets of quantities be plotted along the same coördinates, the lines of equal resistance will be common to both pairs.

The diagram shown has been plotted with falls of potential in volts and distances in feet along the vertical, and with currents in amperes and areas in circular mils along the horizontal. Resistance lines have also been drawn, which are common to both sets of quantities. If now we wish to determine the size of a wire necessary to carry a certain current at a known fall of potential over a given distance, we follow the line of the resistance determined by the current and fall of potential till it intersects the line corresponding to the given distance, and this point determines the area of the copper wire required.

If, as an instance, it is required to find the wire necessary to carry a current of eighty amperes over a circuit of sixteen hundred feet at a hundred volts, the allowable loss of potential being five per cent, we immediately see that the line of .0625 resistance is determined by a current of eighty amperes and five volts loss, and if now this line is followed till it intersects the horizontal line corresponding to 1600 feet, we find that a copper wire of 269,768 C. M. has the required cross-section.

[illegible]

The most available form of this diagram for every-day work is one where the resistance lines have been drawn to correspond to the loss of potential generally allowed, thus avoiding the confusion of a number of useless resistance lines. The resistance lines we have chosen are those corresponding to a fall of potential of either 2½, 5, 10 or 15 volts.

CARRYING CAPACITY OF COPPER WIRES.

Very many tables and formulæ have been offered for evidence in determining the carrying capacity of copper wires for electrical currents, and since the original limit set by the London Board of Trade, 1,000 amperes per square inch, nearer and nearer approximations to what may be called a true figure have been arrived at through the experimental results of the various physicists whose attention has been turned to this problem.

For long lines in the air carrying moderate amounts of current the wire in which the loss of electromotive force is not excessive will ordinarily be of sufficient size as regards heating, but where the amounts of current to be carried become large, or where short lengths are to be run, the closest attention needs be paid to this particular.

It need not be urged that especial care be taken where lights are run over wires concealed in mouldings or under the plaster of a house.

Fortunately, the formulæ at present at the disposal of the electrician are so safe that a fire from an overheated wire in normal running has become entirely an unknown thing, and with the most ordinary care must be impossible.

We have selected the formulæ of Forbes and Kennelly in calculating the following tables, the former relating entirely to wires suspended out of doors in the free air, while the formulæ of Kennelly discuss the problem of interior insulated and concealed wiring, the rise of temperature being in all cases 18° F. It will be noticed that the carrying capacity of a wire is increased by its insulating coating—this is a phenomenon observed by all experimenting along this line, and is explained by the greater radiating surface offered by the insulation as well as by the increased radiating power of the dark surfaces.

CARRYING CAPACITY OF WIRES.

Size, B. & S. Gauge.	Circular Mils.	Forbes.		Kennely.					1000 Amperes per Square Inch.
		Bright.	Black.	Paneled Wire.	Bright Wire suspended in Room.	Black Copper suspended in Room.	Bright Copper suspended Out-doors.	Black Copper suspended Out-doors.	
......	600 000	271.	374.	381.	288.	370.	706.	744.	471.
......	550 000	254.	350.	357.	272.	349.	662.	698.	432.
......	500 000	236.	326.	332.	255.	329.	618.	652.	393.
......	450 000	218.	301.	307.	238.	303.	572.	602.	353.
......	400 000	200.	276.	281.	220.	280.	524.	552.	314.
......	350 000	181.	250.	254.	202.	255.	476.	500.	275.
......	300 000	161.	222.	227.	183.	229.	425.	447.	236.
......	250 000	141.	194.	198.	163.	203.	372.	391.	196.
0000	211 600	124.	171.	174.	146.	181.	329.	346.	166.
000	167 805	104.	144.	146.	127.	155.	278.	292.	132.
00	133 079	88.	121.	123.	110.	133.	236.	247.	105.
0	105 534	74.	102.	103.	95.	114.	199.	209.	83.
1	83 694	63.	86.	88.	83.	98.	169.	177.	66.
2	66 373	52.	72.	73.	72.	85.	141.	148.	52.
3	52 633	44.	60.	61.	63.	73.	121.	127.	41.
4	41 742	37.	51.	52.	55.	63.	103.	108.	33.
5	33 102	30.8	43.	43.	48.	55.	88.	91.	26.
6	26 250	25.9	36.	36.	42.	47.	75.	78.	20.6
7	20 817	21.8	30.	31.	37.	41.	63.	66.	16.3
8	16 509	18.3	25.3	25.7	32.	36.	54.	56.	13.0
9	13 094	15.4	21.2	21.6	28.2	31.	46.	48.	10.3
10	10 381	12.9	17.8	18.2	24.9	27.2	40.	41.	8.2
11	8 234	10.9	15.0	15.3	21.9	23.8	34.	35.	6.5
12	6 530	9.1	12.6	12.8	19.3	20.8	29.	30.	5.1
13	5 178	7.7	10.6	10.8	17.0	18.3	25.	25.8	4.1
14	4 107	6.4	8.9	9.1	15.0	16.0	21.5	22.2	3.2
15	3 257	5.4	7.5	7.6	13.3	14.1	18.5	19.1	2.6
16	2 583	4.6	6.3	6.4	11.8	12.4	16.0	16.5	2.0
17	2 048	3.8	5.2	5.4	10.4	10.9	13.8	14.2	1.6
18	1 624	3.2	5.0	5.1	9.2	9.6	12.0	12.3	1.3
19	1 288	2.7	3.7	3.8	8.2	8.5	10.4	10.7	1.0
20	1 022	2.3	3.1	3.2	7.2	7.5	9.0	9.2	.8

TABLE OF DIAMETER OF WIRES IN STRAND

No. of Wires.	Area in									
	50 000	75 000	100 000	125 000	150 000	175 000	200 000	225 000	250 000	275 000
	Diameter of									
1	223.6	273.8	316.2	353.5	387.3	418.3	447.2	474.3	500.0	524.4
3	129.1	158.1	182.5	204.1	223.6	241.5	258.1	273.8	288.6	302.7
7	84.5	103.5	120.3	133.6	146.3	158.1	169.0	179.2	189.0	198.2
19	51.3	62.8	72.5	81.1	88.9	95.9	102.5	108.8	114.7	120.3
37	36.7	45.0	51.9	58.1	63.6	68.7	73.5	77.9	82.1	86.2
61	28.6	35.1	40.5	45.2	49.6	53.6	57.2	60.7	64.0	67.1
84	24.3	29.8	34.5	38.5	42.2	45.6	48.7	51.7	54.5	57.2
91	23.4	28.7	33.1	37.0	40.6	43.8	46.8	49.7	52.4	54.9
127	19.9	24.3	28.0	31.5	34.3	37.1	39.6	42.1	44.3	46.5
133	19.3	23.7	27.3	30.6	33.5	36.2	38.7	41.1	43.3	45.4
169	17.2	21.0	24.3	27.1	29.7	32.1	34.4	36.4	38.4	40.3
217	15.1	18.5	21.4	24.0	26.2	28.3	30.4	32.2	33.9	35.5

No. of Wires.	Area in								
	550 000	575 000	600 000	625 000	650 000	675 000	700 000	725 000	750 000
	Diameter of								
1	741.6	758.2	774.6	790.5	806.2	821.5	836.6	851.4	866.0
3	428.1	437.8	447.2	456.4	465.4	474.3	483.1	491.4	500.0
7	280.3	286.6	292.7	298.8	304.7	310.5	316.3	321.8	327.3
19	170.1	173.9	177.6	181.3	184.9	188.4	191.9	195.3	198.6
37	121.9	124.6	127.3	129.9	132.5	135.0	137.5	139.9	142.3
61	94.9	97.1	99.1	101.2	103.2	105.1	107.1	109.0	110.8
84	80.9	82.7	84.5	86.2	87.9	89.6	91.2	92.9	94.4
91	77.7	79.4	81.2	82.8	84.5	86.1	87.7	89.2	90.7
127	65.8	67.2	68.7	70.1	71.5	72.9	74.2	75.5	76.8
133	64.2	65.7	67.1	68.5	69.9	71.2	72.5	73.8	75.0
169	57.1	58.3	59.5	60.8	62.0	63.1	64.3	65.4	66.6
217	50.3	51.4	52.5	53.6	54.7	55.7	56.7	57.8	58.8

EQUIVALENT TO GIVEN CIRCULAR MILAGES.

CIRCULAR MILS.

300 000	325 000	350 000	375 000	400 000	425 000	450 000	475 000	500 000	525 000
WIRES IN MILS.									
547.7	570.1	591.6	612.4	632.4	651.9	670.8	689.2	707.1	724.5
316.2	329.1	341.5	353.5	365.1	376.3	387.2	398.0	408.2	418.3
207.0	215.5	223.6	231.4	239.0	246.4	253.5	260.5	267.2	273.8
125.6	130.7	135.7	140.5	145.0	149.5	153.8	158.1	162.2	166.2
90.0	93.7	97.2	100.6	103.9	107.1	110.3	113.3	116.2	119.1
70.1	73.0	75.7	78.4	80.9	83.4	85.8	88.2	90.5	92.7
59.8	62.2	64.5	66.8	69.0	71.1	73.1	75.1	77.1	79.0
57.4	59.7	62.0	64.1	66.3	68.3	70.3	72.2	74.1	75.9
48.6	50.5	52.6	54.3	56.1	57.8	59.5	61.1	62.7	64.2
47.4	49.4	51.2	53.0	54.8	56.5	58.1	59.7	61.3	62.8
42.1	43.8	45.5	47.1	48.6	50.1	51.6	53.0	54.3	55.7
37.1	38.7	40.1	41.6	42.9	44.2	45.5	46.7	48.0	49.1

CIRCULAR MILS.

775 000	800 000	825 000	850 000	875 000	900 000	925 000	950 000	975 000	1 000 000
WIRES IN MILS.									
880.3	894.4	908.3	921.9	935.4	948.6	961.7	974.6	987.4	1 000.0
508.2	516.3	524.4	532.2	540.1	547.7	555.2	562.7	570.0	577.3
332.7	338.0	343.3	348.4	353.5	358.5	363.5	368.4	373.2	377.0
201.9	205.0	208.3	211.5	214.5	217.6	220.6	223.6	226.5	229.4
144.7	147.0	149.3	151.5	153.7	155.9	158.1	160.2	162.3	164.4
112.7	114.5	116.2	118.0	119.7	121.4	123.1	124.7	126.4	128.0
96.0	97.5	99.1	100.5	102.0	103.5	104.9	106.3	107.1	109.1
92.2	93.7	95.2	96.6	98.0	99.5	100.8	102.1	103.5	104.8
78.1	79.3	80.5	81.8	83.0	84.1	85.3	86.4	87.6	88.7
76.3	77.5	78.7	79.9	81.1	82.2	83.3	84.5	85.6	86.7
67.7	68.7	69.8	70.9	71.9	72.9	73.9	74.9	75.9	76.9
59.7	60.7	61.6	62.5	63.4	64.4	65.2	66.1	67.0	67.8

NOTE.—To find the size wire necessary to make a strand of given Circular Milage and of a given number of wires find from above table the diameter in mils of wire corresponding to size of strand and number of wires in strand. Then, by inspection of any table showing sizes in B. & S. Gauge, the desired gauge of wire can be found.

TABLE SHOWING DIAMETER IN MILS OF A GIVEN NUMBER OF WIRES LAID UP IN STRANDS.

No. of Wires.	4/0000	3/0000	2/0000	0000	000	00	0	1	2	3	4	5
1	920.0	796.7	650.5	460.	409.6	364.8	324.9	289.3	257.6	229.4	204.3	181.9
3	531.2	460.0	375.6	265.6	236.5	210.6	187.5	167.0	148.7	132.4	117.9	105.0
7	346.2	301.1	245.9	173.9	154.8	137.9	122.8	109.3	97.3	86.7	77.2	68.7
19	211.1	182.7	149.2	105.5	93.9	83.7	74.5	66.3	59.1	52.6	46.9	41.7
37	151.2	131.0	106.9	75.6	67.3	59.9	53.4	47.5	42.3	37.7	33.6	29.9
49	131.4	113.8	92.9	65.7	58.5	52.1	46.4	41.3	36.8	32.8	29.2	25.9
61	117.8	102.0	83.3	58.9	52.4	46.7	41.6	37.0	32.9	29.4	26.1	23.3
84	100.3	86.9	70.9	50.2	44.7	39.8	35.4	31.5	28.1	25.0	22.3	19.9
91	96.4	83.5	68.2	48.2	42.9	38.2	34.0	30.3	27.0	24.0	21.4	19.0
133	79.7	69.0	56.4	39.9	35.5	31.6	28.2	25.0	22.3	19 9	17.7	15.7

No. of Wires.	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	162.0	144.3	128.5	114.4	101.9	90.7	80.8	72.	64.1	57.1	50.8	45.3	40.3	35.9	32.
3	93.5	83.3	74.2	66.0	58.9	52.4	46.7	41.5	37.0	32.9	29.3	26.1	23.3	20.7	18.4
7	61.2	54.5	48.6	43.3	38.5	34.3	30.5	27.2	24.2	21.6	19.2	17.1	15.2	13.6	12.1
19	37.2	33.1	29.5	26.3	23.4	20.8	18.5	16.5	14.7	13.0	11.7	10.3	9.2	8.2	7.3
37	26.6	23.7	21.1	18.8	16.8										
49	23.1	20.6	18.4	16.3	14.5										
61	20.7	18.5	16.4	14.6	13.0										
84	17.7	15.7	14.0	12.4	11.1										
91	16.9	15.1	13.5	11.9	10.7										
133	14.0	12.5	11.1	9.9	8.8										

TABLES OF LENGTHS AND STRAINS IN SPANS OF WIRE AND SUSPENSION CABLES.

The tables of lengths and strains in spans of wire and cables here given are calculated from the formulæ derived from the equation of a parabola, which is the curve assumed by a wire hanging between two points of suspension unloaded, except by its own weight.

Since telegraph poles are ordinarily spaced by the number per mile, and the distance on an electric railroad or city lighting plant are laid out by the foot, two tables are given based on the usage in the two different cases, which also has determined the selection of different proportionated deflections.

It has been found by observation that the practice with telegraph lines is to allow a deflection of about .005 of the span, though there is no rule set, and the actual amount depends upon the lineman and the appliances for tightening the line which are at his disposal; with the heavier soft copper wires the custom has been to allow two or three times this deflection, and in some of our cities the unsightliness of the overhead wires is largely due to lack of attention to the possibilities of uniformity and small deflection in the spans. The table of lengths gives the actual lengths of wire between the points of suspension required by each different amount of deflection, and the table of strains is one in which a factor is given by which the weight per foot of the suspended wire is to be multiplied in order to ascertain the total strain at the center of the span. The strain at the point of suspension is slightly greater, but the difference is negligable in comparison with the chafing and cutting effect of the tie wire by which the line is fastened to the insulators.

In the case of a weight suspended at the center of the span, as is the case with arc lamp and trolley wire suspenders, the general solution is too intricate for tabulation, and either half the weight may be added to the total tension, or the weight per foot be increased by a proportionate amount of the extra suspended weight, and the factor of safety be increased as with either method the result obtained will be somewhat too low.

TABLE OF TOTAL LENGTH OF WIRE CORRES

Poles to Mile.	Spans in Feet.	Per Cent.				
		.004	.006	.008	.010	.015
20	264.0	264.011	264.025	264.045	264.070	264.158
21	251.4	251.410	251.424	251.442	251.466	251.550
22	240.0	240.010	240.023	240.040	240.063	240.144
23	229.5	229.509	229.522	229.539	229.561	229.637
24	220.0	220.009	220.021	220.037	220.058	220.132
25	211.2	211.209	211.202	211.236	211.256	211.326
26	203.0	203.008	203.019	203.034	203.053	203.121
27	195.5	195.508	195.518	195.533	195.552	195.617
28	188.5	188.508	188.518	188.532	188.550	188.613
29	182.0	182.007	182.017	182.031	182.048	182.109
30	176.0	176.007	176.016	176.030	176.046	176.105
31	170.3	170.307	170.316	170.329	170.345	170.402
32	165.0	165.007	165.015	165.028	165.043	165.099
33	160.0	160.006	160.015	160.027	160.042	160.096
34	155.3	155.306	155.314	155.326	155.341	155.393
35	150.8	150.806	150.814	150.825	150.840	150.890
36	146.6	146.606	146.614	146.625	146.638	146.687
37	142.7	142.706	142.713	142.724	142.737	142.785
38	138.9	138.905	138.913	138.923	138.937	138.983
39	135.4	135.405	135.412	135.423	135.436	135.481
40	132.0	132.005	132.012	132.022	132.035	132.079
41	128.8	128.805	128.812	128.821	128.834	128.877
42	125.7	125.705	125.712	125.721	125.733	125.775
43	122.8	122.805	122.811	122.820	122.832	122.873
44	120.0	120.005	120.011	120.020	120.031	120.072
45	117.3	117.305	117.311	117.320	117.331	117.370
46	114.7	114.704	114.711	114.719	114.730	114.768
47	112.3	112.304	112.310	112.319	112.329	112.367
48	110.0	110.004	110.010	110.018	110.029	110.066
49	107.7	107.704	107.710	107.718	107.728	107.764
50	105.6	105.604	105.610	105.618	105.628	105.663

PONDING TO A GIVEN PERCENTAGE DEFLECTION.

DEFLECTIONS.

.020	.025	.030	.035	.040	.045	.050
264.281	264.440	264.633	264.862	265.126	265.425	265.760
251.668	251.819	252.003	252.221	252.472	252.757	253.076
240.255	240.400	240.576	240.784	241.024	241.296	241.600
229.744	229.882	230.050	230.249	230.479	230.739	231.030
220.234	220.366	220.528	220.718	220.938	221.188	221.466
211.424	211.552	211.706	211.889	212.101	212.340	212.608
203.216	203.338	203.487	203.663	203.866	204.096	204.353
195.708	195.825	195.969	196.138	196.334	196.555	196.803
188.700	188.814	188.952	189.115	189.304	189.517	189.756
182.193	182.303	182.436	182.594	182.776	182.982	183.213
176.187	176.193	176.422	176.574	176.750	176.950	177.173
170.481	170.583	170.708	170.856	171.026	171.219	171.435
165.176	165.275	165.396	165.539	165.704	165.891	166.100
160.170	160.266	160.384	160.522	160.682	160.864	161.066
155.465	155.558	155.672	155.807	155.962	156.138	156.335
150.960	151.051	151.161	151.292	151.443	151.614	151.805
146.756	146.844	146.951	147.078	147.225	147.391	147.577
142.852	142.937	143.042	143.166	143.308	143.470	143.651
139.048	139.131	139.233	139.353	139.492	139.650	139.826
135.544	135.625	135.724	135.842	135.977	136.131	136.302
132.140	132.220	132.316	132.431	132.563	132.712	132.880
128.937	129.014	129.109	129.220	129.349	129.495	129.658
125.834	125.909	126.001	126.110	126.236	126.378	126.538
122.930	123.004	123.094	123.201	123.323	123.463	123.618
120.128	120.200	120.288	120.392	120.512	120.648	120.800
117.425	117.495	117.581	117.683	117.800	117.933	118.082
114.822	114.891	114.975	115.074	115.189	115.319	115.464
112.419	112.487	112.569	112.666	112.779	112.906	113.048
110.116	110.183	110.264	110.359	110.469	110.594	110.733
107.814	107.879	107.958	108.051	108.159	108.281	108.418
105.712	105.776	105.853	105.944	106.050	106.170	106.304

TABLE OF TOTAL LENGTH OF WIRE CORRES

Spans in Feet.	Per Cent.						
	.010	.015	.020	.025	.030	.035	.040
10	10.002	10.006	10.010	10.016	10.024	10.032	10.042
20	20.005	20.012	20.021	20.033	20.048	20.065	20.085
30	30.008	30.018	30.032	30.050	30.072	30.098	30.128
40	40.010	40.024	40.042	40.066	40.096	40.130	40.170
50	50.013	50.030	50.053	50.083	50.120	50.163	50.213
60	60.016	60.036	60.064	60.100	60.144	60.196	60.256
70	70.018	70.042	70.074	70.116	70.168	70.228	70.298
80	80.021	80.048	80.085	80.133	80.192	80.261	80.341
90	90.024	90.054	90.096	90.150	90.216	90.294	90.384
100	100.026	100.060	100.106	100.166	100.240	100.326	100.426
110	110.029	110.066	110.117	110.183	110.264	110.359	110.469
120	120.032	120.072	120.128	120.200	120.288	120.392	120.512
130	130.034	130.078	130.138	130.216	130.312	130.424	130.554
140	140.037	140.084	140.149	140.233	140.336	140.457	140.597
150	150.040	150.090	150.160	150.250	150.360	150.490	150.640
160	160.042	160.096	160.170	160.266	160.384	160.522	160.682
170	170.045	170.102	170.181	170.283	170.408	170.555	170.725
180	180.048	180.108	180.192	180.300	180.432	180.588	180.768
190	190.050	190.114	190.202	190.316	190.456	190.620	190.810
200	200.053	200.120	200.213	200.333	200.480	200.653	200.853

Spans in Feet.	Per Cent.						
	.085	.090	.095	.100	.110	.120	.130
10	10.192	10.216	10.240	10.266	10.322	10.384	10.450
20	20.385	20.432	20.481	20.533	20.645	20.768	20.901
30	30.578	30.648	30.722	30.800	30.968	31.152	31.352
40	40.770	40.864	40.962	41.066	41.290	41.536	41.802
50	50.963	51.080	51.203	51.333	51.613	51.920	52.253
60	61.156	61.296	61.444	61.600	61.936	62.304	62.704
70	71.348	71.512	71.684	71.866	72.258	72.688	73.154
80	81.541	81.728	81.925	82.133	82.581	83.072	83.605
90	91.734	91.944	92.166	92.400	92.904	93.456	94.056
100	101.926	102.160	102.406	102.666	103.226	103.840	104.506
110	112.119	112.376	112.647	112.933	113.549	114.224	114.957
120	122.312	122.592	122.888	123.200	123.872	124.608	125.408
130	132.504	132.808	133.128	133.466	134.194	134.992	135.858
140	142.697	143.024	143.369	143.733	144.517	145.376	146.309
150	152.890	153.240	153.610	154.000	154 840	155.760	156.760
160	163.082	163.456	163.850	164.266	165.162	166.144	167.210
170	173.275	173.672	174.091	174.533	175.485	176.528	177.661
180	183.468	183.888	184.332	184.800	185.808	186.912	188.112
190	193.660	194.104	194.572	195.066	196.130	197.296	198.562
200	203.853	204.320	204.813	205.333	206.453	207.680	209.013

PONDING TO A GIVEN PERCENTAGE DEFLECTION.

DEFLECTION.

.045	.050	.055	.060	.065	.070	.075	.080
10.054	10.066	10.080	10.096	10.112	10.130	10.150	10.170
20.108	20.133	20.161	20.192	20.225	20.261	20.300	20.341
30.162	30.200	30.242	30.288	30.338	30.392	30.450	30.512
40.216	40.266	40.322	40.384	40.450	40.522	40.600	40.682
50.270	50.333	50.403	50.480	50.563	50.653	50.750	50.853
60.324	60.400	60.484	60.576	60.676	60.784	60.900	61.024
70.378	70.466	70.564	70.672	70.788	70.914	71.050	71.194
80.432	80.533	80.645	80.768	80.901	81.045	81.200	81.365
90.486	90.600	90.726	90.864	91.014	91.176	91.350	91.536
100.540	100.666	100.806	100.960	101.126	101.306	101.500	101.706
110.594	110.733	110.887	111.056	111.239	111.437	111.650	111.877
120.648	120.800	120.968	121.152	121.352	121.568	121.800	122.048
130.702	130.866	131.048	131.248	131.464	131.698	131.950	132.218
140.756	140.933	141.129	141.344	141.577	141.829	142.100	142.389
150.810	151.000	151.210	151.440	151 690	151.960	152.250	152.560
160.864	161.066	161.290	161.536	161.802	162.090	162.400	162.730
170.918	171.133	171.371	171.632	171.915	172.221	172.550	172.901
180.972	181.200	181.452	181.728	182.028	182.352	182.700	183.072
191.026	191.266	191.532	191.824	192.140	192.482	192.850	193.242
201.080	201.333	201.613	201.920	202.253	202.613	203.000	203.413

DEFLECTION.

.140	.150	.160	.170	.180	.190	.200
10.522	10.600	10.682	10.770	10.864	10.962	11.066
21.045	21.200	21.365	21.541	21.728	21.925	22.133
31.568	31.800	32.048	32.312	32.592	32.888	33.200
42.090	42.400	42.730	43.082	43.456	43.850	44.266
52.613	53.000	53.413	53.853	54.320	54.813	55.333
63.136	63.600	64.096	64.624	65.184	65.776	66.400
73.658	74.200	74.778	75.394	76.048	76.738	77.466
84.181	84.800	85.461	86.165	86.912	87.701	88.533
94.704	95.400	96.144	96.936	97.776	98.664	99.600
105.226	106.000	106.826	107.706	108.640	109.626	110.666
115.749	116.600	117.509	118.477	119.504	120.589	121.733
126.272	127.200	128.192	129.248	130.368	131.552	132.800
136.794	137.800	138.874	140.018	141.232	142.514	143.866
147.317	148.400	149.557	150.789	152.096	153.477	154.933
157.840	159.000	160.240	161.560	162.960	164.440	166.000
168.362	169.600	170.922	172.330	173.824	175.402	177.066
178.885	180.200	181.605	183.101	184.688	186.365	188.133
189.408	190.800	192.288	193.872	195.552	197.328	199.200
199.930	201.400	202.970	204.642	206.416	208.290	210.166
210.453	212.000	213.653	215.413	217.280	219.253	221.333

TABLE OF ACTUAL DEFLECTIONS OF WIRE PERCENTAGE

Poles to Mile.	Length of Span in Feet.	Per Cent. .004	.006	.008	.010	.015
		Deflections				
20	264.0	1.05	1.58	2.11	2.64	3.96
21	251.4	1.01	1.51	2.01	2.51	3.77
22	240.0	0.96	1.44	1.92	2.40	3.60
23	229.5	0.92	1.38	1.84	2.29	3.44
24	220.0	0.88	1.32	1.76	2.20	3.30
25	211.2	0.85	1.27	1.69	2.11	3.17
26	203.0	0.81	1.22	1.62	2.03	3.04
27	195.5	0.78	1.17	1.56	1.95	2.93
28	188.5	0.75	1.13	1.50	1.88	2.83
29	182.0	0.73	1.09	1.45	1.82	2.73
30	176.0	0.70	1.05	1.41	1.76	2.64
31	170.3	0.68	1.02	1.36	1.70	2.55
32	165.0	0.66	0.99	1.32	1.65	2.47
33	160.0	0.64	0.96	1.28	1.60	2.40
34	155.3	0.62	0.93	1.24	1.55	2.33
35	150.8	0.60	0.90	1.21	1.51	2.26
36	146.6	0.59	0.88	1.17	1.47	2.20
37	142.7	0.57	0.86	1.14	1.43	2.14
38	138.9	0.55	0.83	1.11	1.39	2.08
39	135.4	0.54	0.81	1.08	1.35	2.03
40	132.0	0.53	0.79	1.05	1.32	1.98
41	128.8	0.52	0.77	1.03	1.29	1.93
42	125.7	0.50	0.75	1.01	1.26	1.88
43	122.8	0.49	0.74	0.98	1.23	1.84
44	120.0	0.48	0.72	0.96	1.20	1.80
45	117.3	0.47	0.70	0.94	1.17	1.76
46	114.7	0.46	0.69	0.92	1.15	1.72
47	112.3	0.45	0.67	0.90	1.13	1.68
48	110.0	0.44	0.66	0.88	1.10	1.65
49	107.7	0.43	0.65	0.86	1.08	1.62
50	105.6	0.42	0.63	0.84	1.06	1.58

IN FEET CORRESPONDING TO A GIVEN DEFLECTION.

DEFLECTIONS.

.020	.025	.030	.035	.040	.045	.050
IN FEET.						
5.28	6.60	7.92	9.24	10.56	11.88	13.20
5.03	6.29	7.54	8.80	10.05	11.31	12.57
4.80	6.00	7.20	8.40	9.60	10.80	12.00
4.59	5.74	6.88	8.03	9.18	10.33	11.47
4.40	5.50	6.60	7.70	8.80	9.90	11.00
4.22	5.28	6.33	7.39	8.44	9.50	10.56
4.06	5.08	6.09	7.10	8.12	9.14	10.16
3.91	4.89	5.86	6.84	7.82	8.80	9.77
3.77	4.71	5.65	6.60	7.54	8.48	9.42
3.64	4.55	5.46	6.37	7.28	8.19	9.10
3.52	4.40	5.28	6.16	7.04	7.92	8.81
3.41	4.26	5.11	5.96	6.81	7.66	8.51
3.30	4.12	4.95	5.77	6.60	7.42	8.25
3.20	4.00	4.80	5.60	6.40	7.20	8.00
3.11	3.88	4.66	5.44	6.21	6.99	7.76
3.02	3.72	4.52	5.28	6.03	6.79	7.54
2.92	3.66	4.39	5.13	5.86	6.60	7.33
2.85	3.57	4.28	4.99	5.70	6.42	7.13
2.77	3.47	4.16	4.86	5.55	6.25	6.94
2.71	3.38	4.06	4.74	5.41	6.09	6.77
2.64	3.30	3.96	4.62	5.28	5.94	6.60
2.57	3.22	3.86	4.51	5.15	5.80	6.44
2.51	3.14	3.77	4.40	5.02	5.66	6.28
2.45	3.07	3.68	4.30	4.91	5.53	6.14
2.40	3.00	3.60	4.20	4.80	5.40	6.00
2.34	2.93	3.52	4.11	4.69	5.28	5.86
2.29	2.87	3.44	4.01	4.58	5.16	5.73
2.25	2.81	3.38	3.94	4.49	5.05	5.61
2.20	2.75	3.30	3.85	4.40	4.95	5.50
2.15	2.69	3.23	3.77	4.30	4.85	5.38
2.11	2.64	3.16	3.70	4.22	4.75	5.28

TABLE OF ACTUAL DEFLECTIONS OF WIRE PERCENTAGE

Feet.	Per Cent.						
	.010	.015	.020	.025	.030	.035	.040
	Deflection						
10	.1	.150	.200	.250	.300	.350	.400
20	.2	.300	.400	.500	.600	.700	.800
30	.3	.450	.600	.750	.900	1.050	1.200
40	.4	.600	.800	1.000	1.200	1.400	1.600
50	.5	.750	1.000	1.250	1.500	1.750	2.000
60	.6	.900	1.200	1.500	1.800	2.100	2.400
70	.7	1.050	1.400	1.750	2.100	2.450	2.800
80	.8	1.200	1.600	2.000	2.400	2.800	3.200
90	.9	1.350	1.800	2.250	2.700	3.150	3.600
100	1.	1.500	2.000	2.500	3.000	3.500	4.000
110	1.1	1.650	2.300	2.750	3.300	3.850	4.400
120	1.2	1.800	2.400	3.000	3.600	4.200	4.800
130	1.3	1.950	2.600	3 250	3.900	4.550	5.200
140	1.4	2.100	2.800	3.500	4.200	4.900	5.600
150	1.5	2.250	3.000	3.750	4.500	5.250	6.000
160	1.6	2.400	3.200	4.000	4.800	5.600	6.400
170	1.7	2.550	3.400	4.250	5.100	5.950	6.800
180	1.8	2.700	3.600	4.500	5.400	6.300	7.200
190	1.9	2.850	3.800	4.750	5.700	6.650	7.600
200	2.	3.000	4.000	5.000	6.000	7.000	8.000

Feet.	Per Cent						
	.085	.090	.095	.100	.110	.120	.130
	Deflections						
10	.850	.900	.950	1.000	1.100	1.200	1.300
20	1.700	1.800	1.900	2.000	2.200	2.400	2.600
30	2.550	2.700	2.850	3.000	3.300	3.600	3.900
40	3.400	3.600	3.800	4.000	4.400	4.800	5.200
50	4.250	4.500	4.750	5.000	5.500	6.000	6.500
60	5.100	5.400	5.700	6.000	6.600	7.200	7.800
70	5.950	6.300	6.650	7.000	7.700	8.400	9.100
80	6.800	7.200	7.600	8.000	8.800	9.600	10.400
90	7.650	8.100	8.550	9.000	9.900	10.800	11.700
100	8.500	9.000	9.500	10.000	10.000	12.000	13.000
110	9.350	9.900	10.450	11.000	11.100	13.200	14.300
120	10.200	10.800	11.400	12.000	12.200	14.400	15.600
130	11.050	11.700	12.350	13.000	13.300	15.600	16.900
140	11.900	12.600	13.300	14.000	14.400	16.800	18.200
150	12.750	13.500	14.250	15.000	15.500	18.000	19.500
160	13.600	14.400	15.200	16.000	16.600	19.200	20.800
170	14.450	15.300	16.150	17.000	17.700	20.400	22.100
180	15.300	16.200	17.100	18.000	18.800	21.600	23.400
190	16.150	17.100	18.050	19.000	19.900	22.800	24.700
200	17.000	18.000	19.000	20.000	21.000	24.000	26.000

IN FEET CORRESPONDING TO A GIVEN DEFLECTION.

DEFLECTIONS.

.045	.050	.055	.060	.065	.070	.075	.080
IN FEET.							
.450	.500	.550	.600	.650	.700	.750	.800
.900	1.000	1.100	1.200	1.300	1.400	1.500	1.600
1.350	1.500	1.650	1.800	1.950	2.100	2.250	2.400
1.800	2.000	2.200	2.400	2.600	2.800	3.000	3.200
2.250	2.500	2.750	3.000	3.250	3.500	3.750	4.000
2.700	3.000	3.300	3.600	3.900	4.200	4.500	4.800
3.150	3.500	3.850	4.200	4.550	4.900	5.250	5.600
3.600	4.000	4.400	4.800	5.200	5.600	6.000	6.400
4.050	4.500	4.950	5.400	5.850	6.300	6.750	7,200
4.500	5.000	5.500	6.000	6.500	7.000	7.500	8.000
4.950	5.500	6.050	6.600	7.150	7.700	8.250	8.800
5.400	6.000	6.600	7.200	7.800	8.400	9.000	9.600
5.850	6.500	7.150	7.800	8.450	9.100	9.750	10.400
6.300	7.000	7.700	8.400	9.100	9.800	10.500	11.200
6.750	7.500	8.250	9.000	9.750	10.500	11.250	12.000
7.200	8.000	8.800	9.600	10.400	11.200	12.000	12.800
7.650	8.500	9.350	10.200	11.050	11.900	12.750	13.600
8.100	9.000	9.900	10.800	11.700	12.600	13.500	14.400
8.550	9.500	10.450	11.400	12.350	13.300	14.250	15.200
9.000	10.000	11.000	12.000	13.000	14.000	15.000	16.000

DEFLECTIONS.

.140	.150	.160	.170	.180	.190	.200
IN FEET.						
1.400	1.500	1.600	1.700	1.800	1.900	2.000
2.800	3.000	3.200	3.400	3.600	3.800	4.000
4.200	4.500	4.800	5.100	5.400	5.700	6.000
5.600	6.000	6.400	6.800	7.200	7.600	8.000
7.000	7.500	8.000	8.500	9.000	9.500	10.000
8.400	9.000	9.600	10.200	10.800	11.400	12.000
9.800	10.500	11.200	11.900	12.600	13.300	14.000
11.200	12.000	12.800	13.600	14.400	15.200	16.000
12.600	13.500	14.400	15.300	16.200	17.100	18.000
14.000	15.000	16.000	17.000	18.000	19.000	20.000
15.400	16.500	17.600	18.700	19.800	20.900	22.000
16.800	18.000	19.200	20.400	21.600	22.800	24.000
18.200	19.500	20.800	22.100	23.400	24.700	26.000
19.600	21.000	22.400	23.800	25.200	26.600	28.000
21.000	22.500	24.000	25.500	27.000	28.500	30.000
22.400	24.000	25.600	27.200	28.800	30.400	32 000
23.800	25.500	27.200	28.900	30.600	32.300	34.000
25.200	27.000	28.800	30.600	32.400	34.200	36.000
26.600	28.500	30.400	32.300	34.200	36.100	38.000
28.000	30.000	32.000	34.000	36.000	38.000	40.000

TABLE OF STRAINS AT CENTER OF SPANS RESULT

Poles to Mile.	Spans in Feet.	PER CENT.				
		.004	.006	.008	.010	.015
		MULTI				
20	264.0	8 250.176	5 500.264	4 125.352	3 300.440	2 200.660
21	251.4	7 856.417	5 237.751	3 928.460	3 142.919	2 095.628
22	240.0	7 500.160	5 000.240	3 750.320	3 000.400	2 000.600
23	229.5	7 172.028	4 781.479	3 586.243	2 869.132	1 913.073
24	220.0	6 875.146	4 583.553	3 437.793	2 750.366	1 833.883
25	211.2	6 600.140	4 400.211	3 300.281	2 640.352	1 760.528
26	203.0	6 343.885	4 229.369	3 172.145	2 537.838	1 692.174
27	195.5	6 109.505	4 073.112	3 054.948	2 444.075	1 629.655
28	188.5	5 890.750	3 927.271	2 945.563	2 356.564	1 571.304
29	182.0	5 687.621	3 791.848	2 843.992	2 275.303	1 517.121
30	176.0	5 500.117	3 666.842	2 750.234	2 200.293	1 467.106
31	170.3	5 321.988	3 548.086	2 661.164	2 129.033	1 419.592
32	165.0	5 136.360	3 437.665	2 578.345	2 062.775	1 375.412
33	160.0	5 000.106	3 333.493	2 500.213	2 000.266	1 333.733
34	155.3	4 853.228	3 235.571	2 426.769	1 941.508	1 294.554
35	150.8	4 712.600	3 141.817	2 356.451	1 885.251	1 257.043
36	146.6	4 581.347	3 054.313	2 290.820	1 832.744	1 222.033
37	142.7	4 459.470	2 973.059	2 229.877	1 783.987	1 189.523
38	138.9	4 340.717	2 893.888	2 170.497	1 736.481	1 157.847
39	135.4	4 231.840	2 820.968	2 115.805	1 692.725	1 128.671
40	132.0	4 125.088	2 750.132	2 062.676	1 650.220	1 100.330
41	128.8	4 025.085	2 683.462	2 012.671	1 610.214	1 073.655
42	125.7	3 928.208	2 618.875	1 964.230	1 571.459	1 047.814
43	122.8	3 837.581	2 558.456	1 918.913	1 535.204	1 023.640
44	120.0	3 750.080	2 500.120	1 875.160	1 500.200	1 000.300
45	117.3	3 665.703	2 443.867	1 832.968	1 466.445	977.793
46	114.7	3 584.451	2 389.698	1 792.339	1 433.941	956.120
47	112.3	3 509.449	2 339.695	1 754.836	1 403.937	936.114
48	110.0	3 437.573	2 291.776	1 718.896	1 375.183	916.941
49	107.7	3 365.696	2 243.857	1 682.955	1 346.429	897.769
50	105.6	3 300.070	2 200.105	1 650.140	1 320.176	880.264

ING FROM A GIVEN PERCENTAGE DEFLECTION.

DEFLECTIONS.						
.020	.025	.030	.035	.040	.045	.050
PLIERS.						
1 650.880	1 321.100	1 101.320	944.397	826.760	735.313	662.200
1 572.088	1 258.047	1 048.757	899.323	787.301	700.218	630.595
1 500.800	1 201.000	1 001.200	858.542	751.600	668.466	602.000
1 435.140	1 148.456	957.364	820.981	718.717	639.221	575.662
1 375.733	1 100.916	917.766	786.997	688.966	612.761	551.833
1 320.704	1 056.880	881.056	755.517	661.408	588.250	529.760
1 269.426	1 015.845	846.848	726.184	635.728	565.410	509.191
1 222.526	978.314	815.560	699.354	612.240	544.521	490.379
1 178.753	943.285	786.359	674.314	590.319	525.024	472.820
1 138.106	910.758	759.243	658.204	569.963	506.920	456.516
1 100.586	880.733	734.213	629.598	551.173	490.208	441.466
1 064.942	852.209	710.434	609.207	533.322	474.332	427.169
1 031.800	825.687	688.325	590.248	516.725	459.570	413.875
1 000.533	800.666	667.466	572.361	501.066	445.644	401.333
971.142	777.147	647.859	555.548	486.347	432.552	389.544
943.002	754.628	629.087	539.451	472.255	420.019	378.256
916.738	733.610	611.566	524.426	459.102	408.321	367.721
892.350	714.096	595.296	510.475	446.888	397.459	357.939
868.588	695.078	579.444	496.881	434.988	386.875	348.407
846.701	677.564	564.843	484.361	424.027	377.126	339.628
825.440	660.550	550.660	472.198	413.380	367.656	331.100
805.429	644.536	537.310	460.751	403.358	358.743	323.073
786.044	629.023	524.378	449.661	393.650	350.109	315.297
767.909	614.511	512.280	439.287	384.568	342.032	308.023
750.400	600.500	500.600	429.271	375.800	334.233	301.000
733.516	586.988	489.336	419.612	367.344	326.713	294.227
717.257	573.977	478.490	410.311	359.202	319.471	287.705
702.249	561.967	468.478	401.726	351.686	312.786	281.685
687.866	550.458	458.883	393.498	344.483	306.380	275.916
673.484	538.948	449.288	385.271	337.280	299.974	270.147
660.352	528.440	440.528	377.758	330.704	294.125	264.880

RULE.—To find strain in pounds on wire of given span and deflection, multiply numbers in column answering to wire span and deflection by the weight per foot of wire.

TABLE OF STRAINS AT CENTER OF SPANS RESULTING FROM A GIVEN PERCENTAGE DEFLECTION.

Spans in Feet.	Per Cent. Deflections.										
	.001	.002	.003	.004	.005	.006	.007	.008	.009	.010	.015
	Multipliers.										
10	1 250.001	625.003	416.671	312.506	250.008	208.343	178.583	156.263	138.903	125.016	83.358
20	2 500.003	1 250.006	833.343	625.013	500.016	416.686	357.166	312.526	277.807	250.033	166.716
30	3 750.005	1 875.010	1 250.015	937.520	750.025	625.030	535.749	468.790	416.711	375.050	250.075
40	5 000.006	2 500.013	1 666.686	1 250.026	1 000.033	833.373	714.332	625.053	555.615	500.066	333.433
50	6 250.008	3 125.016	2 083.358	1 562.533	1 250.041	1 041.716	892.915	781.316	694.519	625.083	416.791
60	7 500.010	3 750.020	2 500.030	1 875.040	1 500.050	1 250.060	1 071.498	937.580	833.423	750.100	500.150
70	8 750.011	4 375.023	2 916.701	2 187.546	1 750.058	1 458.403	1 250.081	1 093.843	972.327	875.116	583.508
80	10 000.013	5 000.026	3 333.373	2 500.053	2 000.066	1 666.746	1 428.664	1 250.106	1 111.231	1 000.133	666.866
90	11 250.015	5 625.030	3 750.045	2 812.560	2 250.075	1 875.090	1 607.247	1 406.370	1 250.135	1 125.150	750.225
100	12 500.016	6 250.033	4 166.716	3 125.066	2 500.083	2 083.433	1 785.830	1 562.633	1 389.038	1 250 166	833.583
110	13 750.018	6 875.036	4 583.388	3 437.573	2 750.091	2 291.776	1 964.414	1 718.896	1 527.942	1 375.183	916.941
120	15 000.020	7 500.040	5 000.060	3 750.080	3 000.100	2 500.120	2 142.997	1 875.160	1 666.846	1 500.200	1 000.300
130	16 250.021	8 125.043	5 416.731	4 062.586	3 250.108	2 708.463	2 321.580	2 031.423	1 805.750	1 625.216	1 083.658
140	17 500.023	8 750.046	5 833.403	4 375.093	3 500.116	2 916.806	2 500.163	2 187.686	1 944.654	1 750.233	1 167.016
150	18 750.025	9 375.050	6 250.075	4 687.600	3 750.125	3 125.150	2 678.746	2 343.950	2 083.558	1 875.250	1 250.375
160	20 000.026	10 000.053	6 666.746	5 000.106	4 000.133	3 333.493	2 857.329	2 500.213	2 222.462	2 000.266	1 333.733
170	21 250.028	10 625.056	7 083.418	5 312.613	4 250.141	3 541.836	3 035.912	2 656.476	2 361.366	2 125.283	1 417.091
180	22 500.030	11 250.060	7 500.090	5 625.120	4 500.150	3 750.180	3 214.495	2 812.740	2 500.269	2 250.300	1 500.450
190	23 750.031	11 875.063	7 916.761	5 937.626	4 750.158	3 958.523	3 393.078	2 969.003	2 639.173	2 375.316	1 583.808
200	25 000.033	12 500.066	8 333.433	6 250.133	5 000.166	4 166.866	3 571.661	3 125.266	2 778.077	2 500.333	1 667.166

TABLE OF STRAINS AT CENTER OF SPANS RESULTING FROM A GIVEN PERCENTAGE DEFLECTION—*Continued.*

Spans in Feet.	Per Cent. Deflections.											
	.020	.025	.030	.035	.040	.045	.050	.055	.060	.065	.070	.075
	Multipliers.											
10	62.533	50.041	41.716	35.772	31.316	27.852	25.083	22.818	20.933	19.339	17.973	16.791
20	125.066	100.083	83.433	71.545	62.633	55.705	50.166	45.637	41.866	38.678	35.947	33.583
30	187.600	150.125	125.150	107.317	93.950	83.558	75.250	68.456	62.800	58.017	53.921	50.375
40	250.133	200.166	166.866	143.090	125.266	111.411	100.333	91.275	83.733	77.356	71.895	67.166
50	312.666	250.208	208.583	178.863	156.583	139.263	125.416	114.094	104.666	96.695	89.869	83.958
60	375.200	300.250	250.300	214.635	187.900	167.116	150.500	136.913	125.600	116.034	107.842	100.750
70	437.733	350.291	292.016	250.408	219.216	194.969	175.583	159.732	146.533	135.373	125.816	117.541
80	500.266	400.333	333.733	286.180	250.533	222.822	200.666	182.551	167.466	154.712	143.790	134.333
90	562.800	450.375	375.450	321.953	281.850	250.674	225.750	205.370	188.400	174.051	161.764	151.125
100	625.333	500.416	417.166	357.726	313.166	278.527	250.833	228.189	209.333	193.391	179.738	167.916
110	687.866	550.458	458.883	393.498	344.483	306.380	275.916	251.008	230.266	212.730	197.711	184.708
120	750.400	600.500	500.600	429.271	375.800	334.233	301.000	273.827	251.200	232.069	215.685	201.500
130	812.933	650.541	542.316	465.044	407.116	362.086	326.083	296.646	272.133	251.408	233.659	218.291
140	875.466	700.583	584.033	500.816	438.433	389.938	351.166	319.465	293.066	270.747	251.633	235.083
150	938.000	750.625	625.750	536.589	469.750	417.791	376.250	342.284	314.000	290.086	269.607	251.875
160	1 000.533	800.666	667.466	572.361	501.066	445.644	401.333	365.103	334.933	309.425	287.580	268.666
170	1 063.066	850.708	709.183	608.134	532.383	473.497	426.416	387.921	355.866	328.764	305.554	285.458
180	1 125.600	900.750	750.900	643.907	563.700	501.349	451.500	410.740	376.800	348.103	323.528	302.250
190	1 188.133	950.791	792.616	679.679	595.016	529.202	476.583	433.559	397.733	367.442	341.502	319.041
200	1 250.666	1 000.833	834.333	715.452	626.333	557.055	501.666	456.378	418.666	386.782	359.476	335.833

TABLE OF STRAINS AT CENTER OF SPANS RESULTING FROM A GIVEN PERCENTAGE DEFLECTION—*Continued.*

Spans in Feet.	Per Cent. Deflections.														
	.080	.085	.090	.095	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200
	Multipliers.														
10	15.758	14.847	14.038	13.316	12.666	11.546	10.616	9.832	9.161	8.583	8.079	7.636	7.244	6.895	6.583
20	31.516	29.695	28.077	26.632	25.333	23.093	21.233	19.664	18.323	17.166	16.158	15.272	14.488	13.791	13.166
30	47.275	44.542	42.116	39.948	38.000	34.640	31.850	29.496	27.485	25.750	24.237	22.908	21.733	20.686	19.750
40	63.033	59.390	56.155	53.264	50.666	46.187	42.466	39.328	36.647	34.333	32.316	30.545	28.977	27 582	26.333
50	78.791	74.237	70.194	66.581	63.333	57.734	53.083	49.160	45.809	42.916	40.895	38.181	36.222	34.478	32.916
60	94.550	89.085	84.233	79.897	76.000	69.281	63.700	58.992	54.971	51.500	48.475	45.817	43.466	41.373	39.500
70	110.308	103.932	98.272	93.213	88.666	80.828	74.316	68.824	64.133	60.083	56.554	53.453	50.711	48.269	46.083
80	126.066	118.780	112.311	106.529	101.333	92.375	84.933	78.656	73.295	68.666	64.633	61.090	57.955	55.164	52.666
90	141.825	133.627	126.350	119.846	114.000	103.922	95.550	88.488	82.457	77.250	72.712	68.726	65.199	62.060	59.250
100	157.583	148.475	140.388	133.162	126.666	115.469	106.166	98.320	91.619	85.833	80.791	76.362	72.444	68.956	65.833
110	173.341	163.323	154.427	146.478	139.333	127.016	116.783	108.152	100.780	94.416	88.870	83.999	79.688	75.851	72.416
120	189.100	178.170	168.466	159.794	152.000	138.563	127.400	117.984	109.942	103.000	96.950	91.635	86.933	82.747	79.000
130	204.858	193.018	182.505	173.110	164.666	150.110	138.016	127.816	119.104	111.583	105.029	99.271	94.177	89.642	85.583
140	220.616	207.865	196.544	186.427	177.333	161.657	148.633	137.648	128.266	120.166	113.108	106.907	101.422	96.538	92.166
150	236.375	222.713	210.583	199.743	190.000	173.204	159.250	147.480	137.428	128.750	121.187	114.544	108.666	103.434	98.750
160	252.133	237.560	224.622	213.059	202.666	184.751	169.866	157.312	146.590	137.333	129.266	122.180	115.911	110.329	105.833
170	267.891	252.408	238.661	226.375	215.333	196.298	180.483	167.144	155.752	145.916	137.345	129.816	123.155	117.225	111.916
180	283.650	267.255	252.700	239.692	228.000	207.845	191.100	176.976	164.914	154.500	145.425	137.452	130.399	124.121	118.500
190	299.408	282.103	266.738	253.008	240.666	219.392	201.716	186.808	174.076	163.083	153.504	145.089	137.644	131.016	125.083
200	315.166	296.950	280.777	266.324	253.333	230.939	212.333	196.641	183.238	171.666	161.583	152.725	144.888	137.912	131.666

Rule.—To find strain in pounds on wire of given span and deflection, multiply numbers in column answering to wire span and deflection by the weight per foot of wire.

WEIGHTS OF INSULATED WIRE.

Size, B. & S. Gauge.	Circular Mils.	Weight per 1000 Feet.			Weight per Mile.		
		Bare Wire.	Double-Braided Weatherproof.	Triple-Braided Weatherproof.	Bare Wire.	Double-Braided Weatherproof.	Triple-Braided Weatherproof.
......	500 000.	1 600	......	1 867	8 448	....	9 858
......	450 000.	1 440	... ..	1 680	7 603	....	8 870
......	400 000.	1 280	......	1 493	6 758	....	7 883
......	350 000.	1 120	......	1 307	5 914	....	6 901
......	300 000.	960	......	1 120	5 069	....	5 914
......	250 000.	800	......	933	4 224	....	4 926
0000	211 600.	641	703	739	3 386	3 712	3 902
000	167 805.	508	565	598	2 685	2 983	3 157
00	133 079.2	403	454	485	2 129	2 397	2 561
0	105 534.0	320	366	395	1 688	1 932	2 086
1	83 694.0	254	288	313	1 339	1 521	1 653
2	66 373.0	201	232	251	1 062	1 225	1 325
3	52 633.4	160	187	205	842	987	1 082
4	41 742.5	126	152	168	668	803	887
5	33 102.3	100	123	139	530	649	734
6	26 250.5	80	100	113	420	528	597
7	20 817.0	63	77	88	333	407	465
8	16 509.0	50	63	74	264	333	391
9	13 094.0	40	52	61	210	275	322
10	10 381.0	31	43	51	166	227	269
11	8 234.1	25	36	43	132	190	227
12	6 529.9	20	29	37	105	153	195

GALVANIZED STRANDS.

Seven Wires.	Diameter.	Weight per 1000 Feet.			Estimated Breaking Strength.	Seven Wires.	Diameter.	Weight per 1000 Feet.			Estimated Breaking Strength.
		Bare Strand.	Double-Braided Weatherproof.	Triple-Braided Weatherproof.				Bare Strand.	Double-Braided Weatherproof.	Triple-Braided Weatherproof.	
No. 8	$\frac{1}{2}$	520	616	677	8 320	No. 15	$\frac{1}{4}$	100	148	163	1 600
9	$\frac{15}{32}$	420	510	561	6 720	16	$\frac{7}{32}$	80	122	134	1 280
10	$\frac{7}{16}$	360	444	488	5 720	17	$\frac{3}{16}$	60	96	105	960
11	$\frac{3}{8}$	290	362	398	4 640	18	$\frac{11}{64}$	43	76	84	688
12	$\frac{5}{16}$	210	270	297	3 360	19	$\frac{9}{64}$	33	60	66	528
13	$\frac{9}{32}$	160	214	235	2 560	20	$\frac{1}{8}$	24	48	53	384
14	$\frac{17}{64}$	120	171	188	1 920	21	$\frac{3}{32}$	20	38	42	320

TABLE OF GALVANIZED E. B. B. TELEGRAPH WIRE.

Size, B. W. G.	Weight per Mile.	Resistance per Mile in Ohms.	Breaking Weight.	Twists in 6 inches.	Size, B. W. G.	Weight per Mile.	Resistance per Mile in Ohms.	Breaking Weight.	Twists in 6 inches.
4	730	6.34	1 898	18	10	260	17.79	676	24
6	540	8.45	1 404	19	11	214	21.61	556	25
8	380	12.17	988	21	12	165	28.03	429	27
9	330	14.01	858	22	14	96	48.18	250	28

WROUGHT-IRON WELDED STEAM, GAS AND WATER PIPE.

Table of Standard Dimensions, as manufactured by National Tube Works Company.

Diameter.				Circumference.		Transverse Areas.			Length of Pipe per Sq. Ft. of				
Nominal Internal.	Actual External.	Actual Internal.	Thickness.	External.	Internal.	External.	Internal.	Metal.	External Surface	Internal Surface.	Length of Pipe containing one Cubic foot.	Nominal Weight per foot.	No. of Threads per inch of Screw.
In.	Inches.	Inches.	Inches.	Inches.	Inches.	Sq. In.	Sq. In.	Sq. In.	Feet.	Feet.	Feet.	Pounds.	
1/8	.405	.270	.068	1.272	.848	.129	.057 3	.071 7	9.440	14.15	2 513.0	.241	27
1/4	.540	.364	.088	1.696	1.144	.229	.104 1	.124 9	7.075	10.49	1 383.3	.420	18
3/8	.675	.494	.091	2.121	1.552	.358	.191 7	.166 3	5.657	7.73	751.2	.559	18
1/2	.840	.623	.109	2.639	1.957	.554	.304 8	.249 2	4.547	6.13	472.4	.837	14
3/4	1.050	.824	.113	3.299	2.589	.866	.533 3	.332 7	3.637	4.635	270.0	1.115	14
1	1.315	1.048	.134	4.131	3.292	1.358	.862 6	.495 4	2.904	3.645	166.9	1.668	11½
1¼	1.660	1.380	.140	5.215	4.335	2.164	1.496	.668	2.301	2.768	96.25	2.244	11½
1½	1.900	1.611	.145	5.969	5.061	2.835	2.038	.797	2.010	2.371	70.66	2.678	11½
2	2.375	2.067	.154	7.461	6.494	4.430	3.356	1.074	1.608	1.848	42.91	3.609	11½
2½	2.875	2.468	.204	9.032	7.753	6.492	4.784	1.708	1.328	1.547	30.10	5.739	8
3	3.500	3.067	.217	10.996	9.636	9.621	7.388	2.243	1.091	1.245	19.50	7.536	8
3½	4.000	3.548	.226	12.566	11.146	12.566	9.887	2.679	.955	1.077	14.57	9.001	8
4	4.500	4.026	.237	14.137	12.648	15.904	12.730	3.174	.849	.949	11.31	10.665	8
4½	5.000	4.508	.246	15.708	14.162	19.635	15.961	3.674	.764	.848	9.02	12.340	8
5	5.563	5.045	.259	17.477	15.849	24.306	19.990	4.316	.687	.757	7.20	14.502	8
6	6.625	6.065	.280	20.813	19.054	34.472	28.888	5.584	.577	.630	4.98	18.762	8
7	7.625	7.023	.301	23.955	22.063	45.664	38.738	6.926	.501	.544	3.72	23.271	8
8	8.625	7.982	.322	27.096	25.076	58.426	50.040	8.386	.443	.478	2.88	28.177	8
9	9.625	8.937	.344	30.238	28.076	72.760	62.730	10.030	.397	.427	2.29	33.701	8
10	10.750	10.019	.366	33.772	31.477	90.763	78.839	11.924	.355	.382	1.82	40.065	8

WEIGHTS AND DIMENSIONS OF LEAD-ENCASED ELECTRIC-LIGHT CABLES.

Size, B. & S.	Number of Wires	Diameter of Wire in Mils.	Area in Circular Mils.	Thickness of Lead.	Paper Insulation.		Fibre Insulation.	
					Outside Diameter.	Weight per 1000 Feet.	Outside Diameter.	Weight per 1000 Feet.
......	61	99	600 000	$\frac{1}{10}$	$1\frac{7}{16}$	4 280	$1\frac{1}{2}$	4 475
......	61	95	550 000	$\frac{1}{10}$	$1\frac{13}{32}$	4 060	$1\frac{15}{32}$	4 245
......	61	91	500 000	$\frac{1}{10}$	$1\frac{3}{8}$	3 745	$1\frac{7}{16}$	4 030
......	61	86	450 000	$\frac{1}{10}$	$1\frac{5}{16}$	3 570	$1\frac{3}{8}$	3 755
......	37	104	400 000	$\frac{1}{10}$	$1\frac{9}{32}$	3 345	$1\frac{11}{32}$	3 520
......	37	97	350 000	$\frac{1}{10}$	$1\frac{7}{32}$	3 070	$1\frac{9}{32}$	3 240
......	27	105	300 000	$\frac{1}{10}$	$1\frac{3}{16}$	2 850	$1\frac{1}{4}$	3 020
......	27	96	250 000	$\frac{1}{10}$	$1\frac{1}{8}$	2 585	$1\frac{3}{16}$	2 755
0000	19	106	211 600	$\frac{3}{32}$	$1\frac{1}{32}$	2 300	$1\frac{3}{32}$	2 425
000	19	94	167 805	$\frac{3}{32}$	1	2 050	$1\frac{1}{16}$	2 175
00	19	84	133 079	$\frac{3}{32}$	$\frac{15}{16}$	1 845	1	1 955
0	19	75	105 534	$\frac{5}{64}$	$\frac{27}{32}$	1 480	$\frac{29}{32}$	1 575
1	7	109	83 694	$\frac{5}{64}$	$\frac{13}{16}$	1 315	$\frac{7}{8}$	1 415
2	7	98	66 373	$\frac{1}{16}$	$\frac{3}{4}$	1 035	$\frac{13}{16}$	1 120
3	7	87	52 633	$\frac{1}{16}$	$\frac{23}{32}$	950	$\frac{25}{32}$	1 035
4	1	204	41 743	$\frac{1}{16}$	$\frac{21}{32}$	875	$\frac{23}{32}$	960
5	1	182	33 102	$\frac{1}{16}$	$\frac{5}{8}$	805	$\frac{11}{16}$	890
6	1	162	26 250	$\frac{1}{16}$	$\frac{39}{64}$	745	$\frac{43}{64}$	825

WEIGHTS AND DIMENSIONS OF LEAD-ENCASED TELEPHONE CABLES.

Number of Pairs.	Outside Diameter.	Weight per 1000 Feet.	Number of Pairs.	Outside Diameter.	Weight per 1000 Feet.
5	$\frac{3}{4}$	775	48	$1\frac{7}{8}$	3 970
7	$\frac{7}{8}$	1 105	56	$1\frac{15}{16}$	4 215
12	1	1 680	61	2	4 415
16	$1\frac{1}{8}$	1 990	75	$2\frac{1}{4}$	5 125
19	$1\frac{1}{4}$	2 285	85	$2\frac{5}{16}$	5 525
27	$1\frac{3}{8}$	2 655	91	$2\frac{3}{8}$	5 865
33	$1\frac{1}{2}$	2 995	100	$2\frac{1}{2}$	6 250
37	$1\frac{5}{8}$	3 305			

WEIGHTS AND DIMENSIONS OF LEAD-ENCASED TELEGRAPH CABLES.

Number of Conductors.	Paper Insulation.		Cotton Insulation.	
	Outside Diameter.	Weight per 1000 Feet.	Outside Diameter.	Weight per 1000 Feet.
5	$\frac{9}{16}$	880	$\frac{13}{16}$	1 280
10	$\frac{11}{16}$	1 200	$\frac{15}{16}$	1 620
15	$\frac{13}{16}$	1 520	$1\frac{1}{16}$	1 960
20	$\frac{15}{16}$	1 860	$1\frac{1}{4}$	2 770
25	$1\frac{1}{16}$	2 210	$1\frac{3}{8}$	3 170
30	$1\frac{1}{4}$	3 020	$1\frac{1}{2}$	3 580
40	$1\frac{3}{8}$	3 520	$1\frac{5}{8}$	4 110
50	$1\frac{1}{2}$	4 020	$1\frac{3}{4}$	4 650
65	$1\frac{5}{8}$	4 640	2	5 310
75	$1\frac{3}{4}$	5 160	$2\frac{1}{8}$	5 860
85	$1\frac{7}{8}$	5 690	$2\frac{1}{4}$	6 430
100	2	6 330	$2\frac{3}{8}$	7 110